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• Drilling and Producing • Refining and Petrochemical • Oil and Gas Pipelining

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Petrochemicals' Limitless Frontier

THE petroleum industry has a dynamic and exciting protége that, judging by its phenomenal growth, may in time outstrip its worthy parent, the refining branch of the industry, in its impact on industrial development. That protége is the petrochemical industry. It had an inauspicious beginning as an outlet for petroleum by-products about 30 years ago. From this obscure start it has developed into a lusty member of the industrial family and now supplies more than 25 per cent of the total chemical requirements of the United States. In another 10 years it is estimated that petrochemicals will be supplying 50 per cent of the nation's total chemical needs.

Petrochemicals are chemicals produced from petroleum and natural gas. They are the foundation for a vast new chemical industry, an industry that springs from research in the laboratories of the petroleum industry itself. Evidence of its rapid expansion is the fact that since 1940 investment in the petrochemicals industry has risen from $350 million to more than $2 billion. Still in its infancy, the 5000 products now produced from petrochemicals will in time total 1,000,000. Even now it is estimated that 500,000 different compounds can be made from petroleum products. Ten years from now 64 billion pounds a year of petrochemical compounds will be produced, representing a probable investment of $5 billion. These estimates are no mere guesses but are carefully arrived at by the research authority of one of the major oil companies, many of whom are now in the business of producing basic petrochemicals.

Petrochemicals are now the major source of organic chemicals. Their end products form an exciting array of compounds that touch every phase of our national life. Synthetic rubber, plastics, textiles, agriculture, medicine, cosmetics, all are dependent in part on petrochemicals for their basic raw materials. In an address recently in Chicago on the impact of petroleum on our civilization Dr. Gustav Egloff stated that "Despite the widespread use of machinery and chemicals, it has been estimated that $13 billion worth of crops are lost every year because of weeds, insects, fungi, and plant diseases. Petroleum will play a primary role in reducing this loss because it will be the major source of fuels for mechanization and of chemicals for pest control."

It is a startling fact that despite the myriad of petrochemical products, they require less than 1 per cent of the total U. S. oil production and only about 5 per cent of the total natural gas production. Petrochemicals, therefore, are not likely to suffer from lack of basic raw materials. Our research laboratories are intensifying their research on new products and basic raw materials that will assure expansion of petrochemicals for years to come. Indeed, petrochemicals, a significant off-shoot of the petroleum industry, may in time equal in importance the petroleum refining branch of the industry itself.

In keeping with our progressive editorial policy, petrochemicals will become an increasingly important part of our editorial coverage in order that readers can keep abreast of the significant developments in this rapidly growing branch of the industry.—K.C.S.

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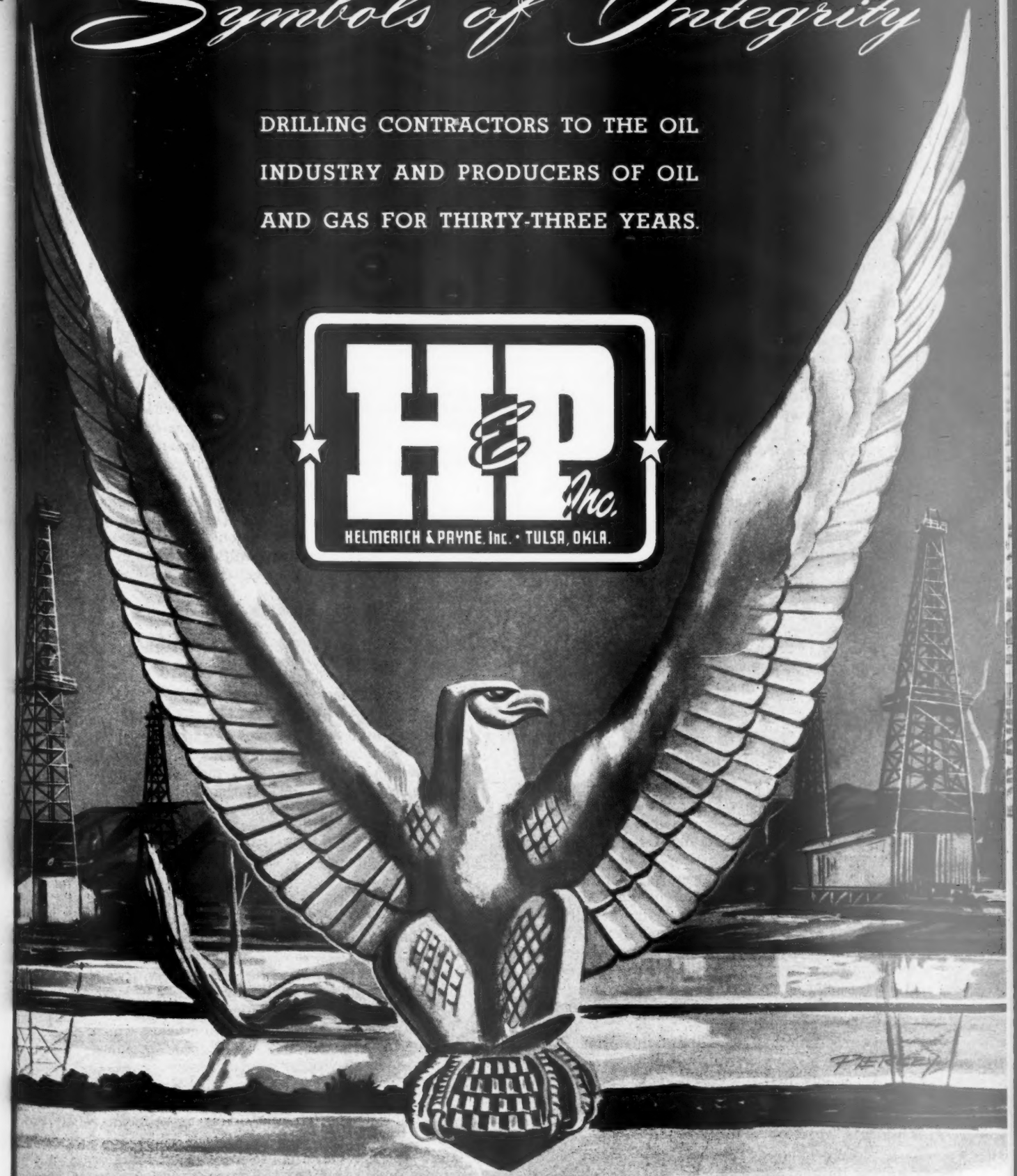

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With the EDITORS.....

New Patent Law Principle

News, and as many informed people think, useful and progressive possibilties exist in the principles set forth in the new patent law, designated Title 35, United States Code, promulgated recently. Its issuance has been called "Blowing the Cobwebs off" the whole patent law system, and so named with some reason, apparently.

Among the outstanding items included in this law is that of interpreting "process" to mean a new use of an old process, material, machine, etc. The whole tenor of the law seems to be a liberalization of patent law in favor of the inventor and the patent owner. Importance of the new use provision should accelerate and stimulate research. This puts another load on the researcher to foresee every use to which a product or process may be put, and to cover it by patent claims.

Another far-reaching principle is that of affirming the patentability of a development by a research group of individuals, a matter that has been denied by courts in the past; a product or process has not been considered patentable if it is the result of group research. The much-argued "flash of genius" requirement given in a court decision some years ago is no longer necessary for a patent to be valid. "A patent shall not be negatived by the manner in which the invention was made".

Legal opinion is largely that in future the recent trend in Federal Courts to sustain patents and declare them infringed will continue and increase, and that patents will have a much greater meaning in science and industry than has been the case during most of the last 25 years. The new law should stimulate invention and research although no furore in these fields has resulted to date. Court decisions are required in order to set the actual limits of interpretation of the new law. The outlook is better than has been the case for two or three decades, informed observers say.—ALF.

Advancements in Pipelining

In the May issue of the Oil and Gas Pipelining Edition of *The Petroleum Engineer*, which is our big annual number, a sincere effort will be made to bring to the reader a cross-section of latest practices and developments. Most of the articles will be written by company men, who are cooperating with us from a desire to do their part in interchanging ideas and findings with the compatriots in the industry. Few of the articles are written by staff members. We feel that the men who have done the work are best qualified to write about it. Only when we believed a subject should be covered, and company men were too burdened with their other duties to assume the task, have we stepped in.

We are certain that you will find this Annual Pipe Line Progress Number, as we call it, of real value and recommend that you give it your close attention when it hits your desk.—F.H.L.

Ethylene Running From Our Ears?

Too early to groan yet, but the rate at which capacity for the production of ethylene and polyethylene is being built and planned offers possibility that for a time at least the nation's output of this all-important petrochemical intermediate may exceed the demand. Yet, since the potential field for utilization of this product is barely scratched, there is more than 50-50 chance that consumption of ethylene may increase quite as rapidly as its production, and the groan of misery become a paean of triumph for the manufacturers and chemical companies.

Gulf Oil just put into operation its first ethylene unit, to make 2½ billion cubic feet per year at Port Arthur, Texas, in the center of petrochemical activity on the Mexican Gulf Coast. That company is already surveying critically the project of building a second unit of like capacity. Understanding is that all this production will be consumed locally in producing plastics, etc., a la polyethylene.

The field is in a state of flux, with a half-dozen companies studying the matter. Some of them have already decided in favor of building ethylene capacity, others still undecided. Some of the answers they need, especially to the question of the ratio of supply to demand in the next 5-10 years, can be given only by time — they may guess wrong or right. National Petrochemical is Mehemet going to the Mountain, perching its plant on the natural gas line in Illinois (Tuscola), to make ethylene from ethane-propane in the gas enroute to serve northern cities. Du Pont, and Union Carbide have such facilities operating or already building. Spencer Chemical, and Jefferson Chemical — Cyanamid and Texas Company — American Petrochemical, various refining companies and other chemical outfits are nursing incipient headaches trying to get enough answers to warrant a decision.

Someone has estimated that we'll use up 350,000,000 lb of ethylene in 1955, probably can produce a half billion pounds by then. Is that guestimate or forecast? — A.L.F.

Gas Reserves Increase Again

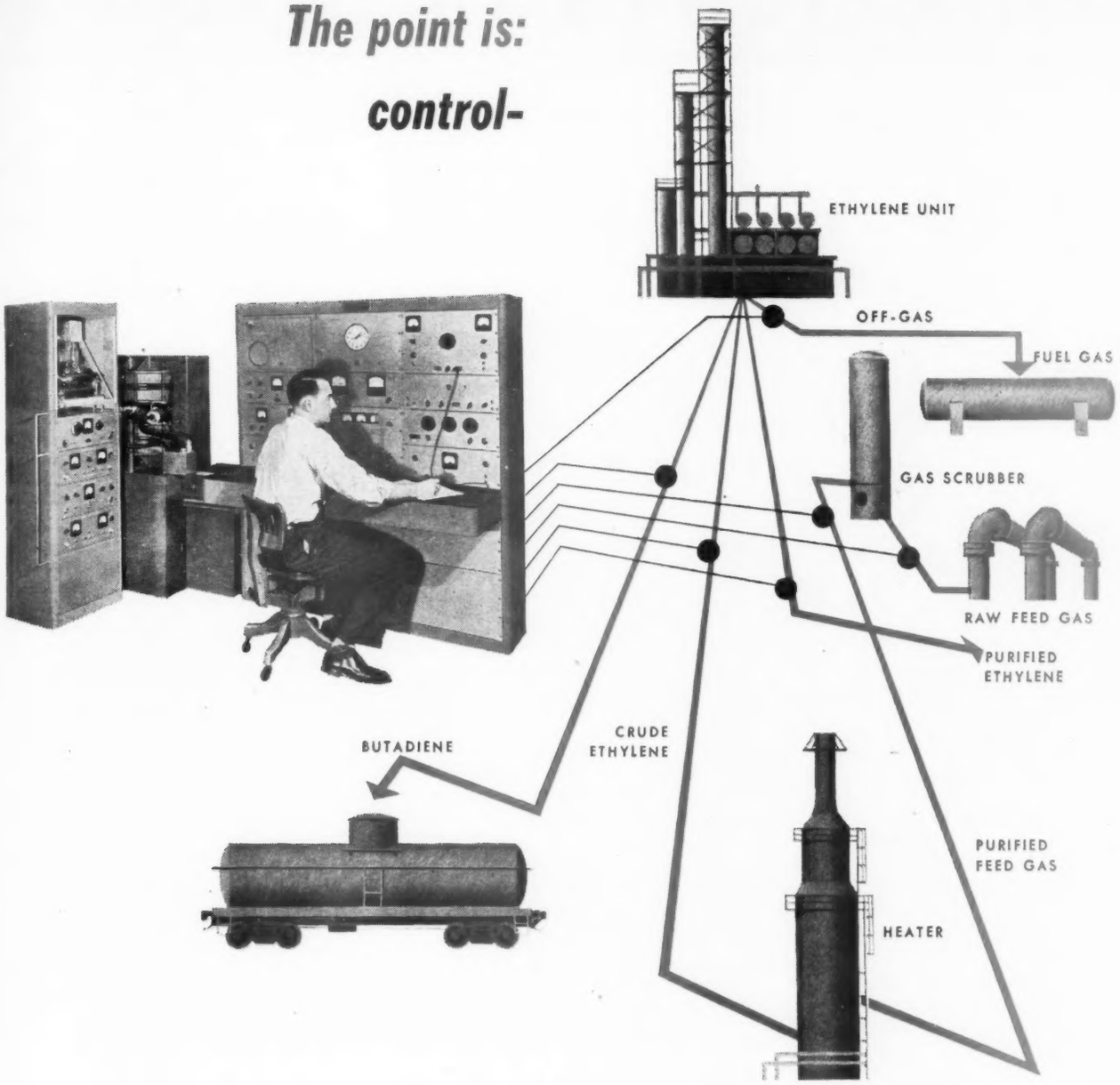
The natural gas industry, and therefore the gas transmission industry, continues in a strong position insofar as supply is concerned. This is revealed in the annual report on reserves by the joint committee of the American Gas Association and the American Petroleum Institute, recently made public.

At the beginning of the year 1953 proved recoverable natural gas reserves in the United States totaled 199.7 trillion cubic feet. A year previously they were 193.8 trillion cubic feet. Thus reserves increased 5.9 trillion cubic feet despite an all-time high production during the year of 8.6 trillion cubic feet.

The extent to which exploration activities increased in 1952 is emphasized by the fact that 5.4 trillion cubic feet of new natural gas reserves were found as compared with 3 trillion cubic feet in 1951. Additionally, 8.9 trillion cubic feet of reserves were added as a result of drilling in existing fields, which necessitated a revision and extension of previous estimates. Such activity, of course, was the direct result of the ever-increasing demand for natural gas. which in turn has been reflected in the rate at which natural gas transmission lines have been constructed in recent years.

Those who may be prone to wave the red flag of pessimism by predicting depletion of natural gas reserves seemingly have nothing concrete as yet to substantiate their contention.—F.H.L.

The point is: control-



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HIGHLIGHTS IN OILDOM

Tidelands Output Seen High

A National Petroleum Council committee has reported that if unhampered by legal and material difficulties, oil companies can produce about 200,000 bbl of oil a day after five years in the Continental Shelf. Report was made by a committee studying oil potentials in the "tidelands" areas lying under water off the U. S. coast, particularly in the Gulf of Mexico and California. In addition to oil, the committee reported that companies could produce approximately 6,000,000 to 8,000,000 cu ft of natural gas a day, and probably would discover "an important number of major oil and gas fields."

Gas Pipe Line Tax

Mississippi Supreme Court has ruled that the state privilege tax on interstate gas pipe lines is unconstitutional, reversing a former decision. The court ruled that the tax violated commerce clause of the Constitution, but had recently held that the state had the right to charge interstate lines a privilege tax for crossing the state although doing no business within its borders.

Oil Flows From Texas Tree

Despite some false rumors Texas does not show any signs of running out of oil —it even runs out of trees in Eastland County. A producer brought in at the William McElroy Ranch Company's No. 1 Farmer went out of control blowing a hole in the ground some distance away near the tree. When the dust settled, oil was flowing from the tree.

IOCC Membership Vetoed

Legislation that would let Wyoming join the Interstate Oil Compact Commission has been vetoed in Cheyenne. Governor C. J. Rogers turned down a bill granting membership, explaining that compact membership might "confuse present orderly production of minerals and may even possibly end by having imposed on citizens and other interests in Wyoming undue restrictions that we may have cause to regret."

Paley Report Denounced

Paley Commission report declaring that the United States should make importing of oil easier has been lambasted by the Petroleum Administration for Defense. Paley Commission, appointed by the Truman Administration to draft national materials policy, suggested cutting or eliminating tariffs on crude oil imports. "Ed Warren, PAD deputy administrator, declared this practice would be neither logical nor realistic." He asserted that there had to be an incentive to oil men to "explore for or develop domestic reserves if there is no market for the commodity," in answer to the commission's suggestion that it would be desirable to conserve domestic petroleum resources and use more foreign crude.

Canada Oil Almost Unlimited

No other country has a more assured supply of petroleum than Canada, Trevor F. Moore, a director of Imperial Oil, told the Fergus Service Club recently. Total Canadian reserves would last the country up to 2000 years at present rates of consumption, he said. Up to 1800 years' supply is estimated to exist in the Alberta tar sands, said Moore, who added that he felt sure the technical difficulties of using these sands would eventually be overcome. As high as 180 years' supply is believed to lie in crude oil fields as yet undiscovered, while known and developed crude reserves were large enough to supply the needs of Canadians for 12 years.

OIIC Film Awarded

For the third year in a row, a motion picture produced by the Oil Industry Information Committee of the American Petroleum Institute has been cited by Freedoms Foundation, Inc., for making an outstanding contribution to the principles of freedom. Latest recipient of this honor is the committee's 1952 picture, "Crossroads, U. S. A." It was released last October, and is a Hollywood production.

New Miracles From Oil

Automobile bodies that will not dent nor rust; everyone in the world well-clothed and housed in attractive quarters; bath tubs that will weigh only about 15 lb. These are only some of the many marvels derived from petroleum that are hiding around the corner, according to Dr. Gustav Egloff, director of research for Universal Oil Products Company, Des Plaines, Illinois.

Wonders that the petroleum industry has in store for the world have been made partly responsible, Dr. Egloff said, by the industry spending $20,000,000,000 since World War II in expanding and improving its facilities and by the planned expenditure of another $4,000,000,000 in 1953. Many miracles will be made possible through the use of petrochemicals, he said.

Better Public Relations

Oil producers should—and are beginning to—learn to handle people as expertly as they drill a well. This is the opinion of a production man, Frank H. Willibrand of Sohio Petroleum Company, Oklahoma City. Based on his two-year chairmanship of an American Petroleum Institute committee on supervisory development, Willibrand put his convictions before almost 1000 fellow oil producers recently in a featured paper at a general session of the API Division of Production spring meeting in Hotel Hilton. The Oklahoman suggested that highly-trained technical men in the oil business match their technological advances with skill in human relations, particularly in handling employees.

German Oil Output Up

Germany's oil output now covers about one-third of its consumption, according to a government information bulletin. New discoveries the past year has been given as cause of rise in production. Last year Germany produced 12,250,000 bbl and is expected to produce more than 14,000,000 bbl in 1953. Largest new discoveries have been made in the Emsland area of lower Saxony, near the Netherlands border.

Oil Reserves Hit New High

Proved reserves of liquid petroleum and natural gas hit new records in 1952, the American Petroleum Institute reported. In both groups substantial increases were made to both known underground stocks despite a new high in output.

In its annual report on the state of the nation's proved reserves API stated that liquid petroleum reserves rose to 32.9 billion barrels, an increase of more than 764,000,000 from 1951. Natural gas reserves rose to 199.7 trillion cubic feet on December 31, up 5.9 trillion from the record high of the preceding year. Other increases were as spectacular.

Middle East Oil

American interest in Middle Eastern oil is directly linked to taxes, peace, and the hopes of the great majority of the world's people of some day attaining a decent standard of living. This was the opinion John S. Sample, vice president of General Petroleum Corporation, expressed before the Whittier University Club. "We have spent thirty billion dollars in Western Europe since the end of World War II. While the taxes we have paid to supply those billions are significant, the total has its real significance as a symbol of our hopes for peace, our hopes for a better world for all of the human race," Sample said.

Oil Imports Quota Sought

Congress has been asked to limit oil imports to 10 per cent of United States demand by the import policy committee of the Independent Petroleum Association of America. "Recent months have brought evidence of the crippling effects of unrestrained imports," a report by the committee said. IPAA asked that Congress impose quota restrictions on quarterly basis.

Elk Hill Increase Sought

Approximately 5000 bbl of oil is wasting underground each day in the Elk Hills naval petroleum reserve in California, Captain Robert H. Meade told the House Armed Services Committee in a recent hearing. Meade, who is director of Naval Petroleum Reserves, recommended steps that would increase oil production from the field by 18,000 bbl a day. Production from Elk Hills last year averaged about 6200 bbl per day.

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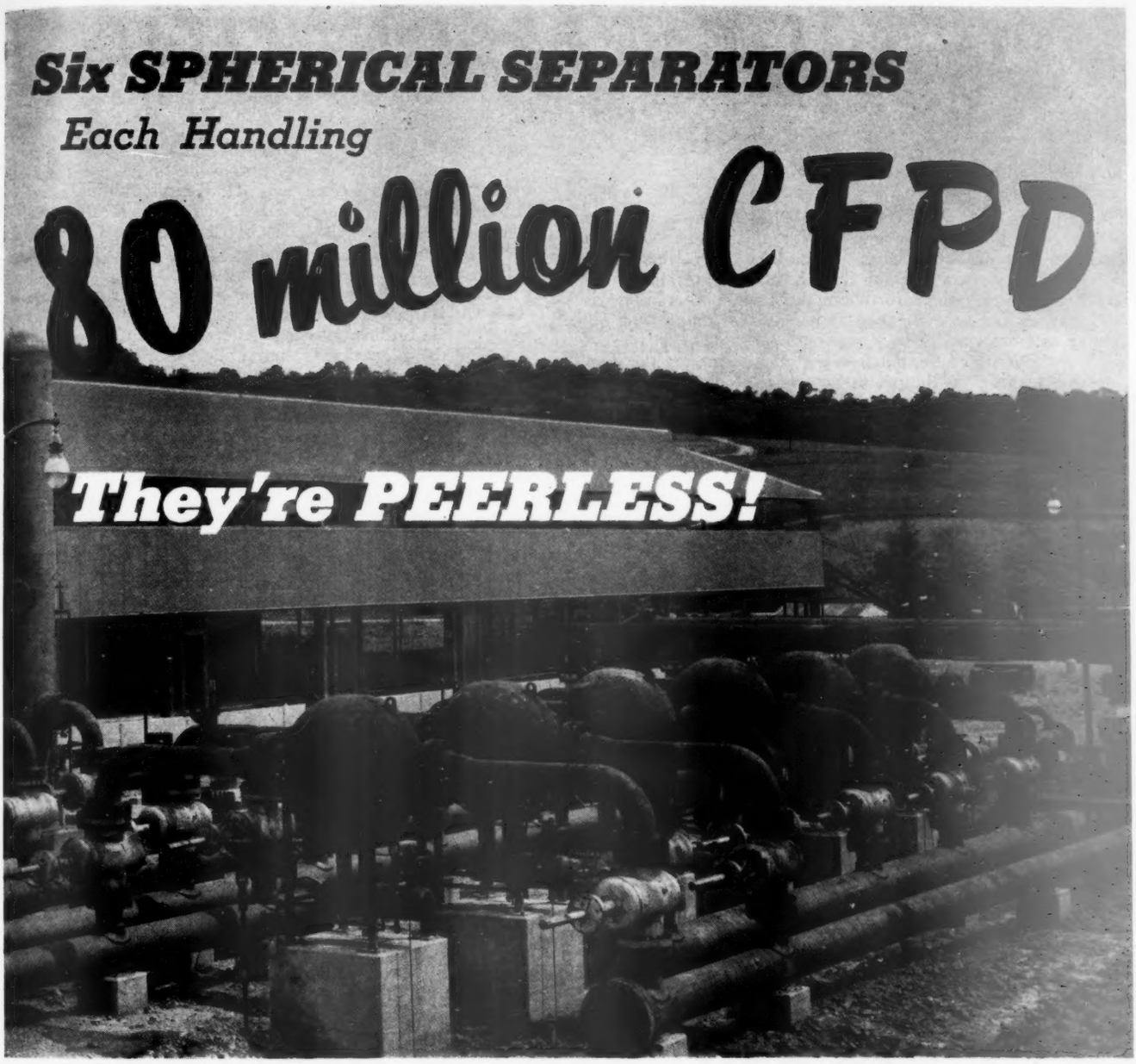

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PETROLIC PERSONALITIES

DICK SNEDDON

Of the Tile Tossers and Such

We had the thrill of a long and severely checkered career one recent lunch hour when coupled with Ed McDowd, the noted Shell scout, we literally scalped two of the fastest domino counters west of Ponca City, to wit, Olen Lane, the Continental Oil Company biggie, and Basil Kantzer, the rapidly climbing Union Oiler. The unfortunate thing about this enterprise was that we had no audience, for it featured some of the best mixing and drawing we have seen in a long time. Most people don't seem to attach too much importance to mixing the dominoes, or "making" as the professionals call it. They scuff things about lazily with one hand while they hold a sandwich in the other and the result is that the game starts with the rocks stone cold. Any experienced tile tosser will tell you that the thing to do is roll up your sleeves and really give the bones a roughing.

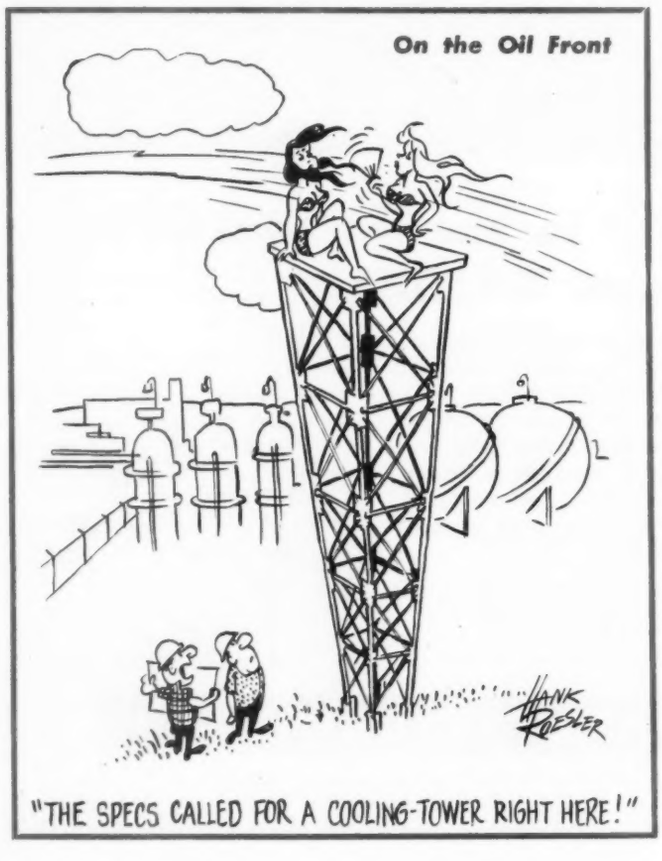
This all took place in the Los Angeles Petroleum Club and, we hate to say it, but our triumph was short lived. A short time thereafter, we were caught in a cut-throat game with Jim Leovy and Paul Broxon, the Western Gulf legal staff, and after what happened, we could certainly charge these boys with malfeasance of some sort, and perhaps even multifariousness and replevin. Anyway, when this duo had finished giving us the squeeze, we had to make a touch from a local loan and usury company which will keep us working long after retirement age.

Earle Jorgensen in Matrimonial Plunge

A very lovely party was given in the Los Angeles Petroleum Club the other day by John Lucas, president of Southwest Welding Company, and Fred Currie, the well known Copperweld chap, in honor of Earle Jorgensen, the steel biggie, who is about to take the matrimonial plunge. Among those present at this most agreeable whingding were Bill de Ridder, chairman of the board, General Metals Corporation; Bill Beck, the Socony purchasing executive from New York; Bill Zander, senior vice president of Rheem Manufacturing Company;

Lionel Sirocco, district sales manager for the Bethlehem Supply Company; Paul Whiteley, purchasing agent for the General Petroleum Corporation; C. H. "Tutt" Tuttle, assistant manager of purchases for Standard of California; Bert Kelly, purchasing agent for Richfield Oil Corporation; Charlie Perkins, assistant manager of purchases for Union Oil Company; Hugh Glen, retired chairman of the board, Emsco Manufacturing Company; Bill Kinder, the Emsconian veep from Garland, Texas; Ott Hammer, president of Security Engineering Corporation; and Al Collins, purchasing agent, Shell Oil Company.

Most of these gentlemen had known Earle Jorgensen for many years and they recited many interesting stories of joint adventures in the more precarious days of yesterday. After each had added his contribution to the Jorgensen saga and had wished Earle the most of the best, Fred Currie and John Lucas, the co-hosts, called in the wedding cake, a luscious affair with a lone bachelor on top, and gave their own inside stories of Earle Jorgensen's contributions to western industry.



Matters of Earth Shaking Consequence

Down to International Geophysics, Inc., at beautiful Westwood recently for a visit with Jay Jakosky and his several aides who have been responsible for the perfection, over some considerable time, of two important developments in seismic recording, namely controlled altitude aerial shooting and the play-back technique. While there had an interesting talk with John J. Jakosky, Jr., and Nolen Webb, the former particularly concerned with the instrument side of the play-back method and the latter a hotshot interpreter, both of whom are naturally pretty enthusiastic about the device.

JJJJr. was born in Pittsburgh, Pennsylvania, and we are very proud that we were able to resist the inclination to say he came "clean" from the iron and steel metropolis. He came to California in 1925, later graduated from University of Southern California in petroleum engineering, and has been an important attachment of IGI ever since. John is a serious minded sort of a chap who seems to be completely engrossed in his work, but he takes time out to play an occasional set or two of tennis at the Bel Air Club, and from what we hear, his service is very good there, too. Nolen Webb is a native of La Rue, Arkansas, but doesn't speak a bit like either Lum or Abner. He is a physics and maths grad from the University of Arkansas at Fayetteville, and is doing an excellent job as chief interpreter for IGI. In his spare moments, Nolen is a divot lofter of amazing prowess. He was teeing off at Bel Air one morning a while ago when the pro strolled up and said, "Sorry, Mr. Webb, but you're not supposed to start off three feet in front of the tee." "Start off nothing," replied Nolen, "this is my third shot." Well, at least the boy is honest.

The Cruise of the Good Ship Alician

We hear tell about another interesting cruise of the comely yacht, Alician, captained by that ubiquitous Long Beach oil man, Lester Callahan, and carrying aboard some mighty important people from down on the water front. Among the guests were Doug Graham, the travelingest drilling contractor in the business, who, as we write is winging his way from New York, and before this is in print will be in Peru; Elmer Decker, the noted weight indicator baron and expert on the matter of quarter horses and, indeed, on any fraction of a horse; and Bob Cook, a Coalinga boy who has had a lot of adventure in and out of the petroleum business, and is a gin rummy sharpie if we ever saw one.

They went aboard the lugger at Newport, hauled in the main halyard, and in no time were nosing through the breakers in the general direction of Mazatlan, bent on some big game fishing. However, they stopped into every inviting bight and bay on the way down, hunted quail, duck, and other small game. The ultimate objective, of course, was to catch a boatload of marlin and sailfish at Mazaatlan, which they eventually did. The accommodations on the Alician are scrumptious, the captain owner, Les Callahan, is a perfect host, and the gang arrived back in Long Beach, marvelously refreshed.

EYES OF THE PETROLEUM WORLD will focus on TULSA, OKLAHOMA May 14-23, 1953

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147 EXPLORATION Exhibits

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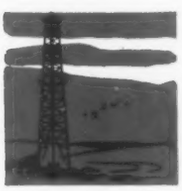
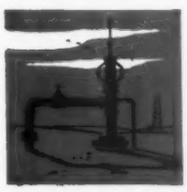


363 DRILLING Exhibits

. . . SEE new drilling machinery and techniques unveiled at IPE . . . Investigate their greater economy and efficiency . . . You will even hear about new "atomic" drilling!

310 REFINING Exhibits

. . . SEE the new amazing processes and equipment developed through research and engineering during the past five years in refinery laboratories . . in natural gasoline and petro-chemicals. Everything imaginable is obtained from a drop of crude oil!



390 PRODUCTION Exhibits

. . . SEE new developments for increasing production, — secondary recovery — improved separation and treating—better, safer storage, servicing, workover.

363 PIPELINE Exhibits

. . . SEE the thrilling saga of the pipeliners — the truly heroic achievements with plastic pipe, new coatings and other new diversified products and services by manufacturers and allied industries in transporting petroleum.

SCIENTIFIC Exhibits

. . . SEE the phenomenal accomplishments of applied science in all phases of the petroleum industry — to be dramatically presented both in the Exposition's HALL OF SCIENCE and in the many company exhibits.

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To supplement first class hotel rooms, the IPE Housing Bureau has secured and checked for quality over 1500 homes, many near the exposition grounds. These rent for $5 to $12 per day per person, and many companies are arranging accommodations for their men in these homes, where there are facilities for entertaining as well as sleeping quarters. Write now for reservations: IPE Housing Bureau, 616 South Boston, Tulsa, Oklahoma.

XUM

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GARLOCK CHEVRON Hydraulic Packings

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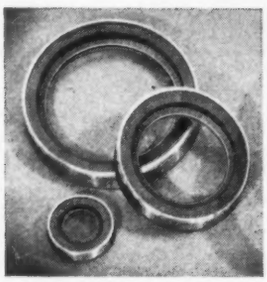
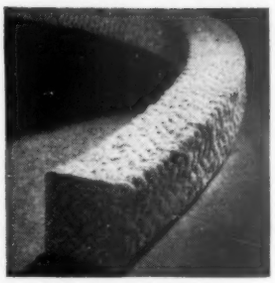


GARLOCK KLOZURE Oil and Grease Seals for Bearings



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Meetings

April 8-10—**American Petroleum Institute,** Division of Production, Eastern District spring meeting, Hotel William Penn, Pittsburgh, Pennsylvania.

April 9-10—**Petroleum Engineering Conference,** General subject: "Secondary Recovery by Water Flooding," University of Kansas, Lawrence, Kansas.

April 10—**Illinois Oil and Gas Association,** 8th annual meeting, Emerson Hotel, Mt. Vernon, Illinois.

April 12-May 23—**Empire Mining and Metallurgical Congress,** Australasian Institute of Mining and Metallurgy, Australia.

April 13-15—**American Society of Lubrication Engineers,** annual meeting and exhibit, Hotel Statler, Boston, Massachusetts.

April 13-15—**Canadian Institute of Mining and Metallurgy,** annual meeting, The McDonald, Edmonton, Alberta, Canada.

April 13-15—**Association of Nebraska Liquefied Petroleum Gas Dealers,** annual meeting, Hotel Fontenelle, Omaha, Nebraska.

April 15-17—**National Petroleum Association,** semi-annual meeting, Hotel Cleveland, Cleveland, Ohio.

April 18—**Oil Discovery Day,** second annual celebration marking discovery of Williston Basin, sponsored by the Williston Junior Chamber of Commerce, Williston, North Dakota.

April 20-22—**American Petroleum Institute,** Division of Transportation, products pipe line conference, Hotel Muehlebach, Kansas City, Missouri.

April 21—**Association of Consulting Chemists and Chemical Engineers, Inc.,** Hotel Belmont Plaza, New York, New York.

April 21-22—**Michigan Petroleum Association,** spring meeting, Detroit-Leland Hotel, Detroit, Michigan.

April 21-23—**Southwestern Gas Measurement Short Course,** University of Oklahoma, Norman, Oklahoma.

April 22-24—**American Institute of Electrical Engineers,** South district No. 4, Louisville, Kentucky.

April 24-25—**Interstate Oil Compact Commission,** spring meeting, Roosevelt Hotel, New Orleans, Louisiana.

April 26-29—**American Institute of Chemical Engineers,** joint meeting with **Chemical Institute of Canada,** Royal York Hotel, Toronto, Canada.

April 27-May 1—**American Petroleum Institute,** Safety and Fire Protection committees, mid-year meeting, Galvez Hotel, Galveston, Texas.

April 27-28—**Independent Petroleum Association of America,** mid-year meeting, Jefferson Hotel, St. Louis, Missouri.

April 29-30—**American Petroleum Institute,** board of directors and executive committee meetings, Texas Hotel, Fort Worth, Texas.

April 29-May 1—**Natural Gasoline Association of America,** annual convention, Rice Hotel, Houston, Texas.

April 30-May 1—**American Gas Association,** transmission and storage conference, Edgewater Beach Hotel, Chicago, Illinois.

May 3-6—**Liquefied Petroleum Gas Association,** annual convention, Conrad Hilton Hotel, Chicago, Illinois.

May 4-5—**American Petroleum Institute,** Division of Marketing, mid-year meeting, Baker Hotel, Dallas, Texas.

May 4-6—**American Geophysical Union,** 34th annual meeting, Washington, D. C.

May 4-6—**American Oil Chemists' Society,** 44th annual meeting, Roosevelt Hotel, Chicago, Illinois.

May 5-6—**Gas Hydrate Control Conference,** annual, Engineering Auditorium, University of Oklahoma, Norman, Oklahoma.

May 7-8—**American Petroleum Institute,** Division of Production, Rocky Mountain district, Gladstone Hotel, Casper, Wyoming.

May 10-12—**Pennsylvania Petroleum Association, Inc.,** Bedford Springs Hotel, Bedford Springs, Pennsylvania.

May 11-13—**Southern Gas Association,** Jung Hotel, New Orleans, Louisiana.

May 11-14—**American Petroleum Institute,** Division of Refining, Hotel Commodore, New York, New York.

May 14-23—**International Petroleum Exposition,** Tulsa, Oklahoma.

May 17-19—**Empire State Petroleum Association,** The Roosevelt, New York, New York.

May 18-19—**American Petroleum Institute,** Committee on Agriculture, annual field trip, Iowa State College, Ames, Iowa.

May 18-21—**Oil Industry Information Committee,** Ambassador Hotel, Los Angeles, California.

May 24-27—**American Gas Association,** production and chemical conference, Hotel New Yorker, New York, New York.

May 27-29—**Short Course in Gas Technology,** annual, Texas College of Arts and Industries, Kingsville, Texas.

May 28-29—**Natural Gas and Petroleum Association of Canada,** London, Ontario, Canada.

May 28-29—**Western Petroleum Refiners Association,** regional meeting, Broadview Hotel, Wichita, Kansas.

June 2-3—**American Petroleum Institute,** Division of Production, Pacific Coast District, Statler Hotel, Los Angeles, California.

June 4-5—**Kentucky Oil and Gas Association,** annual meeting, Lafayette Hotel, Lexington, Kentucky.

June 7-12—**Society of Automotive Engineers,** summer meeting, The Ambassador and Ritz-Carlton, Atlantic City, New Jersey.

June 14-18—**Canadian Gas Association,** Windsor Hotel, Montreal, Canada.

June 15-19—**American Petroleum Institute,** Division of Production, mid-year committee conference, Hotel William Penn, Pittsburgh, Pennsylvania.

June 16-19—**American Welding Society,** national spring technical meeting, Shamrock Hotel, Houston, Texas.

June 16-24—**European Congress for Chemical Engineering,** Paris, France.

June 18-19—**Pennsylvania Grade Crude Oil Association,** annual meeting, Hotel William Penn, Pittsburgh, Pennsylvania.

June 18-19—**Western Petroleum Refiners Association,** regional meeting, Conrad Hilton Hotel, Chicago, Illinois.

June 28-July 2—**Petroleum Equipment Suppliers Association,** annual meeting, Broadmoor Hotel, Colorado Springs, Colorado.

June 29-July 3—**American Society for Testing Materials,** annual meeting, Chalfonte-Haddon, Atlantic City, New Jersey.

August 17-19—**Society of Automotive Engineers,** national West Coast meeting, Georgia Hotel, Vancouver, B. C., Canada.

August 18-21—**American Institute of Electrical Engineers,** Pacific general meeting, Vancouver Hotel, Vancouver, B. C., Canada.

August 18-21—**National Congress of Petroleum Retailers,** William Penn Hotel, Pittsburgh, Pennsylvania.

August 31-Sept. 5—**International Association for Hydraulic Research,** arranged jointly with Hydraulics Division of the **American Society of Civil Engineers,** Minneapolis, Minnesota.

Sept. 6-11—**American Chemical Society,** national meeting, Conrad Hilton Hotel, Chicago, Illinois.

Sept. 10-11—**Desk and Derrick Clubs of North America,** annual convention, Denver, Colorado.

Sept. 13-16—**American Institute of Chemical Engineers,** Fairmont and Mark Hopkins Hotels, San Francisco, California.

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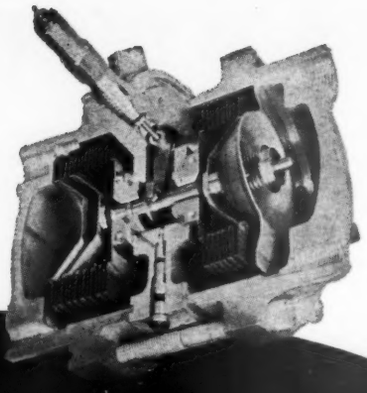
To obtain more information on products advertised see page E-59



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Sept. 15-16—**American Petroleum Institute,** Executive Committee, Greenbrier Hotel, White Sulphur Springs, West Virginia.

Sept. 16-18—**National Petroleum Association,** annual meeting, The Traymore, Atlantic City, New Jersey.

Sept. 21-25—**Instrument Society of America,** conference and exhibit, Chicago, Illinois.

Sept. 24-25—**Western Petroleum Refiners Association,** regional meeting, Henning Hotel, Casper, Wyoming.

Oct. 6-7—**Texas Mid-Continent Oil and Gas Association,** 34th annual meeting, Rice Hotel, Houston, Texas.

Oct. 4-6—**American Association of Oil Well Drilling Contractors,** annual meeting, Denver, Colorado.

Oct. 7-9—**National Association of Corrosion Engineers,** South Central Region, Mayo Hotel, Tulsa, Oklahoma.

Oct. 8-9—**Illinois Institute of Technology,** Conference on Industrial Hydraulics, annual, Hotel Sheraton, Chicago, Illinois.

Oct. 11-17—**Oil Progress Week.**

Oct. 15-16—**Petroleum Marketers Association of Texas,** annual meeting, Adolphus Hotel, Dallas, Texas.

Oct. 19-20—**Independent Petroleum Association of America,** annual meeting, Hotel Texas, Fort Worth, Texas.

Oct. 24—**National Gasoline Association of America,** regional meeting, Blackstone Hotel, Fort Worth, Texas.

Oct. 26-29—**American Gas Association,** annual conference, Kiel Auditorium, St. Louis, Missouri.

Nov. 2-4—**Society of Automotive Engineers,** national transportation meeting, Conrad Hilton Hotel, Chicago, Illinois.

Nov. 2-4—**American Petroleum Credit Association,** 29th annual conference, Biltmore Hotel, New York, New York.

Nov. 5-6—**Society of Automotive Engineers,** national fuels and lubricants division, Conrad Hilton Hotel, Chicago, Illinois.

Nov. 9-11—**The Geological Society of America,** annual meeting, Royal York Hotel, Toronto, Canada.

Nov. 9-17—**American Petroleum Institute,** annual meeting, Conrad Hilton Hotel and Palmer House, Chicago, Illinois.

Nov. 21—**National Gasoline Association of America,** regional meeting, Herring Hotel, Amarillo, Texas.

Nov. 30-Dec. 5—**Exposition of Chemical Industries,** Grand Central Palace, New York, New York.

Nov. 30-Dec. 4—**American Society of Mechanical Engineers,** annual meeting, Hotels Statler and McAlpin, New York, New York.

Dec. 13-16—**American Institute of Chemical Engineers,** annual meeting, Hotel Jefferson, St. Louis, Missouri.

Dec. 28-29—**American Chemical Society,** Division of Industrial and Engineering Chemistry, University of Michigan, Ann Arbor, Mich.

NOMADS TO MEET

New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's New York. Secretary, O. B. Latrobe.

Houston Chapter, Second Monday of the Month, Ye Olde College Inn, Houston, Texas. Secretary, Harry E. Estes.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Executive Secretary, Wallace A. Sawdon.

Tulsa Chapter, Third Friday, "After Five" Room, Hotel Tulsa. Secretary, Gilbert Swift.

Dallas-Fort Worth Chapter, Dallas, Texas. First Monday of the Month. Secretary, M. W. Hiltpold.

B&W BULLETIN 6-F

Properties of Carbon, Alloy and Stainless Steel Tubing for High-Temperature and High-Pressure Service

The Story of the Croloys

New data contained in the seventh, revised edition of B&W's Technical Bulletin 6-F make it must reading for technical personnel concerned with the properties of tubing for high-temperature and high-pressure service. TB-6F contains up-to-the-minute information on:

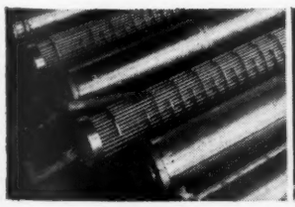
- Requirements of Tubing for High-Temperature Service
- Influence of Alloying Elements
- Chemical Composition
- Room-Temperature Properties
- Short-Time Tensile Properties
- Stress-Rupture Creep
- Thermal Expansion
- Thermal Conductivity
- Impact Properties
- Microstructure—Transformation Temperatures
- Air-Hardening Properties
- Effect of Hydrogen
- Common Causes of Tube Failures
- Upset, Formed and Machined Tube-Ends

On such grades as

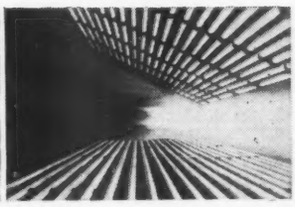
B&W	NOMINAL ALLOY CONTENT	MAXIMUM SERVICE TEMPERATURE
Carbon Steel (Killed)		
Carbon-Moly	0.50% Mo	1050F
Croloy ½	0.60% Cr 0.50% Mo	1075F
Croloy 1	1% Cr ½% Mo	1150F
Croloy 1¼	1.25% Cr 0.50% Mo	1100F
Croloy 2	2% Cr 0.50% Mo	1150F
Croloy 2¼	2.25% Cr 1.00% Mo	1175F
Croloy 3-M	3% Cr 0.90% Mo	1175F

B&W	NOMINAL ALLOY CONTENT	MAXIMUM SERVICE TEMPERATURE
Croloy 5	5% Cr 0.50% Mo	1200F
Croloy 5-Si	5% Cr 0.50% Mo 1.50% Si	1300F
Croloy 7	7% Cr 0.50% Mo	1250F
Croloy 9-M	9% Cr 1% Mo	1300F
Croloy 16-13-3	16% Cr 13% Ni 3% Mo	1600F
Croloy 18-8	18% Cr 8% Ni	1600F
Croloy 25-20	25% Cr 20% Ni	2100F

Write for your copy —on company letterhead, please.



Chemical



Oil

Power

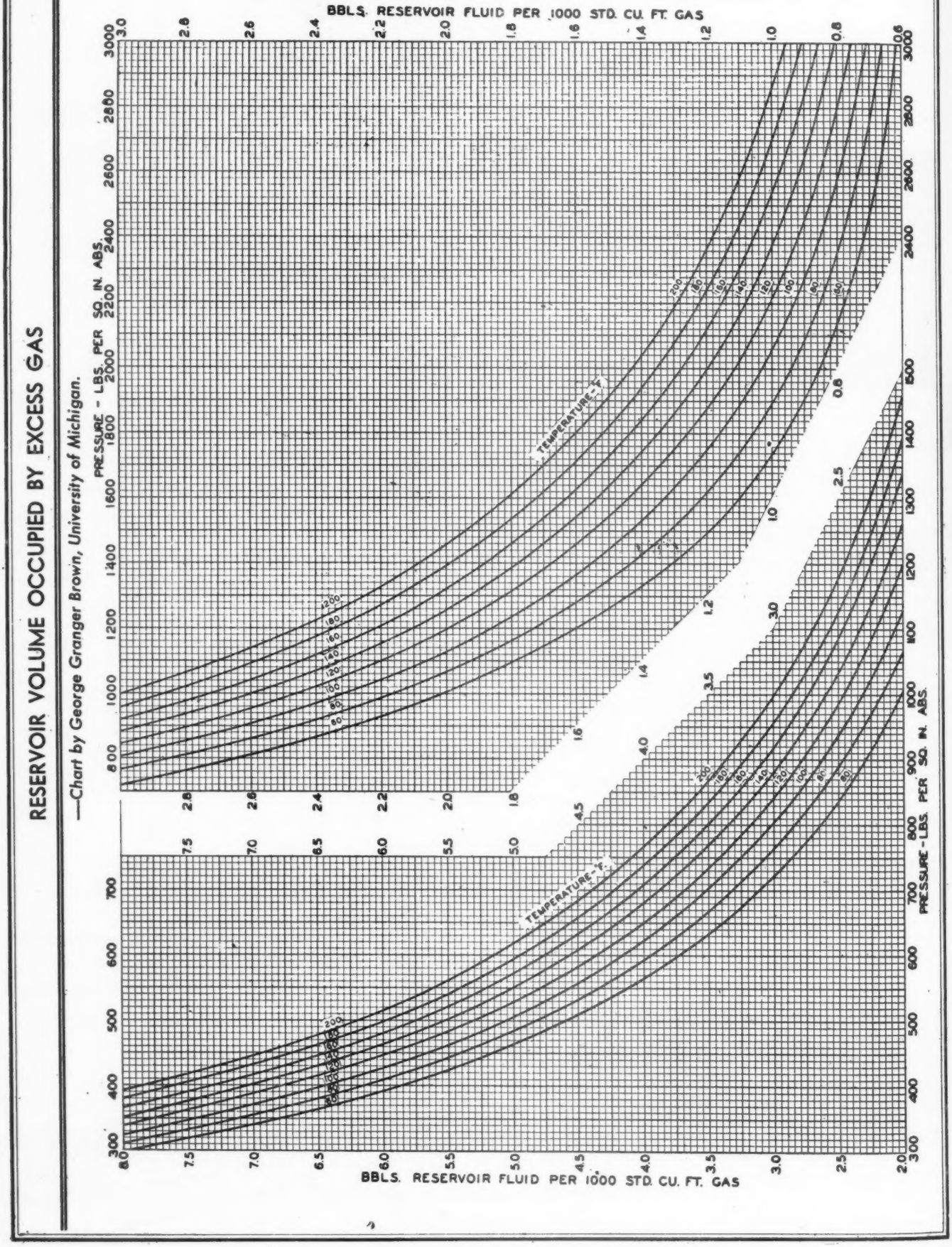
TA-1739 (P)

B&W SEAMLESS and WELDED TUBES

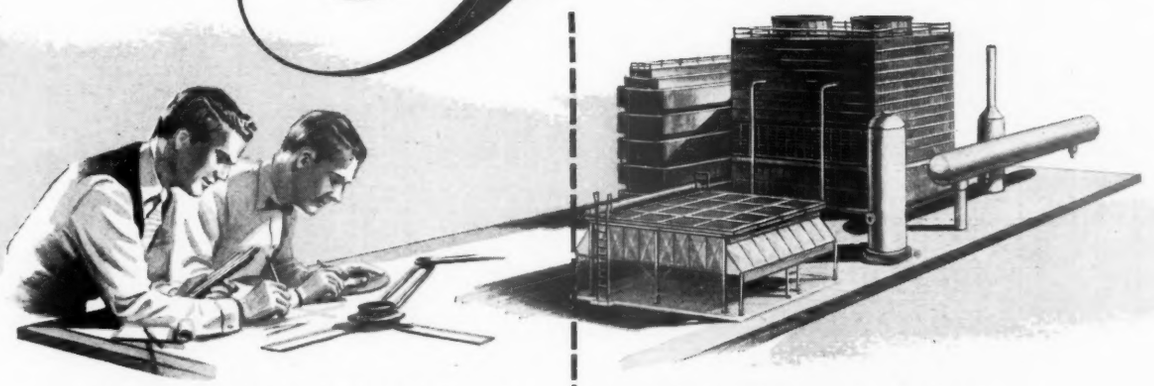
THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

RESERVOIR VOLUME OCCUPIED BY EXCESS GAS

—Chart by George Granger Brown, University of Michigan.


BBLS. RESERVOIR FLUID PER 1000 STD. CU. FT. GAS
PRESSURE - LBS. PER SQ. IN. ABS.
TEMPERATURE - °F.
BBLS. RESERVOIR FLUID PER 1000 STD. CU. FT. GAS
PRESSURE - LBS. PER SQ. IN. ABS.
TEMPERATURE - °F.

BE SURE WITH *Fluor*



IN ENGINEERING AND CONSTRUCTION

Fluor's Engineering and Construction Division is a complete organization for the development of process methods, mechanical design, equipment procurement, field erection and initial operation of plants and facilities for the oil, gas-gasoline, chemical, power and allied industries.

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Fluor's manufactured products include Aerator and Counterflo Cooling Towers, Fin-Fan Air-Cooled Heat Exchangers, Pulsation Dampeners, Mufflers, Gas Cleaners and related equipment. Second to none in quality or performance, Fluor products are in service in petroleum, chemical and power installations throughout the world.

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TULSA

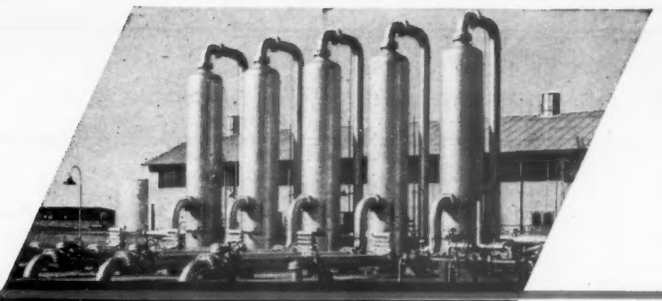
To obtain more information on products advertised see page E-59

TOTAL[1] UPWARD PRESSURE AT WELL HEAD BETWEEN DRILL PIPE AND CASING, LB.

Casing diam., O.D., in.	Drill pipe, diam., O.D., in.	Well head pressure, lb. per sq. in. gauge																	
		1000	2000	3000	3500	4000	4500	5000	5500	6000	6250	6500	6750	7000	7200	7400	7600	7800	8000
8⅝	2⅜	46,050	92,100	138,150	161,170	184,200	207,220	230,240	253,270	276,290	287,810	299,320	310,830	322,340	331,550	340,760	349,970	359,180	368,390
	2⅞	43,990	87,970	131,960	153,950	175,950	197,940	219,940	241,930	263,920	274,920	285,920	296,910	307,910	316,710	325,500	334,300	343,100	351,900
	3½	40,860	81,720	122,570	143,000	163,430	183,860	204,290	224,720	245,150	255,360	265,580	275,790	286,010	294,180	302,350	310,520	318,690	326,860
	4½	34,580	69,150	103,720	121,010	138,300	155,590	172,880	190,160	207,450	216,090	224,740	233,380	242,020	248,940	255,860	262,770	269,680	276,600
	5⁹⁄₁₆	26,170	52,350	78,520	91,610	104,690	117,780	130,860	143,950	157,040	163,580	170,120	176,670	183,210	188,450	193,680	198,910	204,150	209,380
9	2⅜	49,550	99,090	148,640	173,410	198,180	222,960	247,730	272,500	297,280	309,660	322,050	334,440	346,820	357,730	366,640	376,550	386,460	396,370
	2⅞	47,480	94,970	142,450	166,190	189,940	213,680	237,420	261,160	284,900	296,780	308,650	320,520	332,390	341,880	351,380	360,880	370,380	379,870
	3½	44,360	88,710	133,060	155,240	177,420	199,600	221,780	243,950	266,130	277,220	288,310	299,400	310,480	319,360	328,230	337,100	345,970	354,840
	4½	38,070	76,140	114,220	133,250	152,290	171,320	190,360	209,400	228,430	237,950	247,470	256,990	266,500	274,120	281,730	289,350	296,960	304,580
	5⁹⁄₁₆	29,670	59,340	89,010	103,840	118,680	133,520	148,350	163,180	178,020	185,440	192,860	200,270	207,690	213,620	219,560	225,490	231,430	237,360
	6⅝	19,500	39,010	58,510	68,260	78,020	87,770	97,520	107,270	117,020	121,900	126,780	131,650	136,530	140,430	144,330	148,230	152,130	156,030
9⅝	2⅜	58,080	116,150	174,220	203,260	232,300	261,340	290,380	319,410	348,450	362,970	377,490	392,010	406,520	418,140	429,760	441,370	452,980	464,600
	2⅞	56,010	112,030	168,040	196,050	224,050	252,060	280,060	308,070	336,080	350,080	364,080	378,090	392,090	403,290	414,500	425,700	436,900	448,100
	3½	52,880	105,770	158,650	185,090	211,540	237,980	264,420	290,860	317,300	330,520	343,750	356,970	370,190	380,760	391,340	401,920	412,500	423,070
	4½	46,600	93,200	139,800	163,100	186,400	209,700	233,000	256,310	279,610	291,260	302,910	314,560	326,210	335,530	344,850	354,170	363,490	372,810
	5⁹⁄₁₆	38,200	76,400	114,600	133,700	152,800	171,900	191,000	210,090	229,190	238,740	248,290	257,840	267,390	275,030	282,670	290,310	297,950	305,590
	6⅝	28,030	56,070	84,100	98,120	112,130	126,150	140,160	154,180	168,200	175,210	182,210	189,220	196,230	201,840	207,440	213,050	218,660	224,260
10	2⅜	64,730	129,460	194,200	226,560	258,930	291,290	323,660	356,030	388,390	404,580	420,760	436,940	453,120	466,070	479,020	491,960	504,910	517,860
	2⅞	62,670	125,340	188,010	219,340	250,680	282,020	313,350	344,680	376,020	391,690	407,360	423,020	438,690	451,220	463,760	476,290	488,830	501,360
	3½	59,540	119,080	178,620	208,390	238,160	267,930	297,700	327,480	357,250	372,130	387,020	401,900	416,790	428,700	440,600	452,510	464,420	476,330
	4½	53,260	106,520	159,770	186,400	213,030	239,660	266,290	292,920	319,550	332,860	346,180	359,490	372,810	383,460	394,110	404,760	415,410	426,060
	5⁹⁄₁₆	44,860	89,710	134,570	157,000	179,420	201,850	224,280	246,710	269,140	280,350	291,560	302,780	313,990	322,960	331,930	340,910	349,880	358,850
	6⅝	34,690	69,380	104,070	121,420	138,760	156,100	173,450	190,800	208,140	216,810	225,480	234,160	242,830	249,770	256,710	263,640	270,580	277,520
	7⅝	23,500	47,000	70,490	82,240	93,990	105,740	117,490	129,240	140,990	146,860	152,740	158,610	164,490	169,190	173,890	178,580	183,280	187,980
10¾	2⅜	74,900	149,790	224,690	262,140	299,590	337,040	374,480	411,930	449,380	468,110	486,830	505,550	524,280	539,260	554,240	569,220	584,200	599,180
	2⅞	72,840	145,670	218,500	254,920	291,340	327,760	364,180	400,590	437,010	455,220	473,430	491,640	509,840	524,410	538,980	553,550	568,110	582,680
	3½	69,710	139,410	209,120	243,970	278,820	313,680	348,530	383,380	418,240	435,660	453,090	470,520	487,940	501,880	515,820	529,770	543,710	557,650
	4½	63,420	126,850	190,270	221,980	253,690	285,400	317,120	348,830	380,540	396,390	412,250	428,110	443,960	456,650	469,330	482,010	494,700	507,380
	5⁹⁄₁₆	55,020	110,040	165,060	192,570	220,080	247,590	275,100	302,620	330,130	343,880	357,640	371,390	385,150	396,150	407,160	418,160	429,160	440,170
	6⅝	44,860	89,710	134,560	156,990	179,420	201,850	224,280	246,700	269,130	280,340	291,560	302,770	313,980	322,960	331,930	340,900	349,870	358,840
	7⅝	33,660	67,330	100,990	117,820	134,650	151,480	168,320	185,150	201,980	210,390	218,810	227,230	235,640	242,370	249,110	255,840	262,570	269,300
11¾	2⅜	90,600	181,210	271,810	317,110	362,410	407,710	453,020	498,320	543,620	566,270	588,920	611,570	634,220	652,340	670,460	688,580	706,700	724,820
	2⅞	88,540	177,080	265,620	309,890	354,160	398,430	442,700	486,980	531,250	553,380	575,520	597,650	619,790	637,500	655,200	672,910	690,620	708,330
	3½	85,410	170,820	256,240	298,940	341,650	384,350	427,060	469,770	512,470	533,820	555,180	576,530	597,880	614,970	632,050	649,130	666,210	683,300
	4½	79,130	158,260	237,390	276,950	316,520	356,080	395,640	435,210	474,770	494,560	514,340	534,120	553,900	569,730	585,550	601,380	617,210	633,030
	5⁹⁄₁₆	70,730	141,450	212,180	247,540	282,910	318,270	353,640	389,000	424,360	442,040	459,730	477,410	495,090	509,230	523,380	537,530	551,670	565,820
	6⅝	60,560	121,120	181,680	211,960	242,240	272,520	302,800	333,090	363,370	378,510	393,650	408,790	423,930	436,040	448,150	460,260	472,380	484,490
	7⅝	49,370	98,740	148,110	172,790	197,480	222,160	246,840	271,530	296,210	308,560	320,900	333,240	345,580	355,460	365,330	375,200	385,080	394,950
	8⅝	36,610	73,210	109,820	128,120	146,430	164,730	183,040	201,340	219,640	228,790	237,950	247,100	256,250	263,570	270,890	278,210	285,530	292,860

The fact that total well head pressures for unit pressures as high as 8000 lb. per sq. in. are included in the table should not be interpreted as indicating that the casing will have sufficient bursting strength to withstand such pressure. For bursting strength of casing see Table P432.2, p. 257, August, 1937, issue.

[1]Total for lightest weight casing, hence a maximum for each size casing.



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The dust particles in gas passing through a Venturi-type oil spray chamber are thoroughly wetted, regardless of the quantity, pressure and temperature of the gas in the line. There are no moving parts or special mechanisms — the rate of flow of gas through the cleaner automatically determines the quantity of oil that is aspirated with the gas. Because of the variations in suction pressure common to gas transmission service, the gas cleaner is designed to operate through a broad pressure range at full capacity.

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Utilizing the same principles as Model DV, Fluor liquid removal Gas Cleaners possess an exceptional ability to extract liquids through the whole range of operating conditions. Performance of these cleaners is accurately predicted on special nomographs, a new rating system exclusive with Fluor. For full details contact your nearest Fluor office or write for Bulletin GC-0.001.

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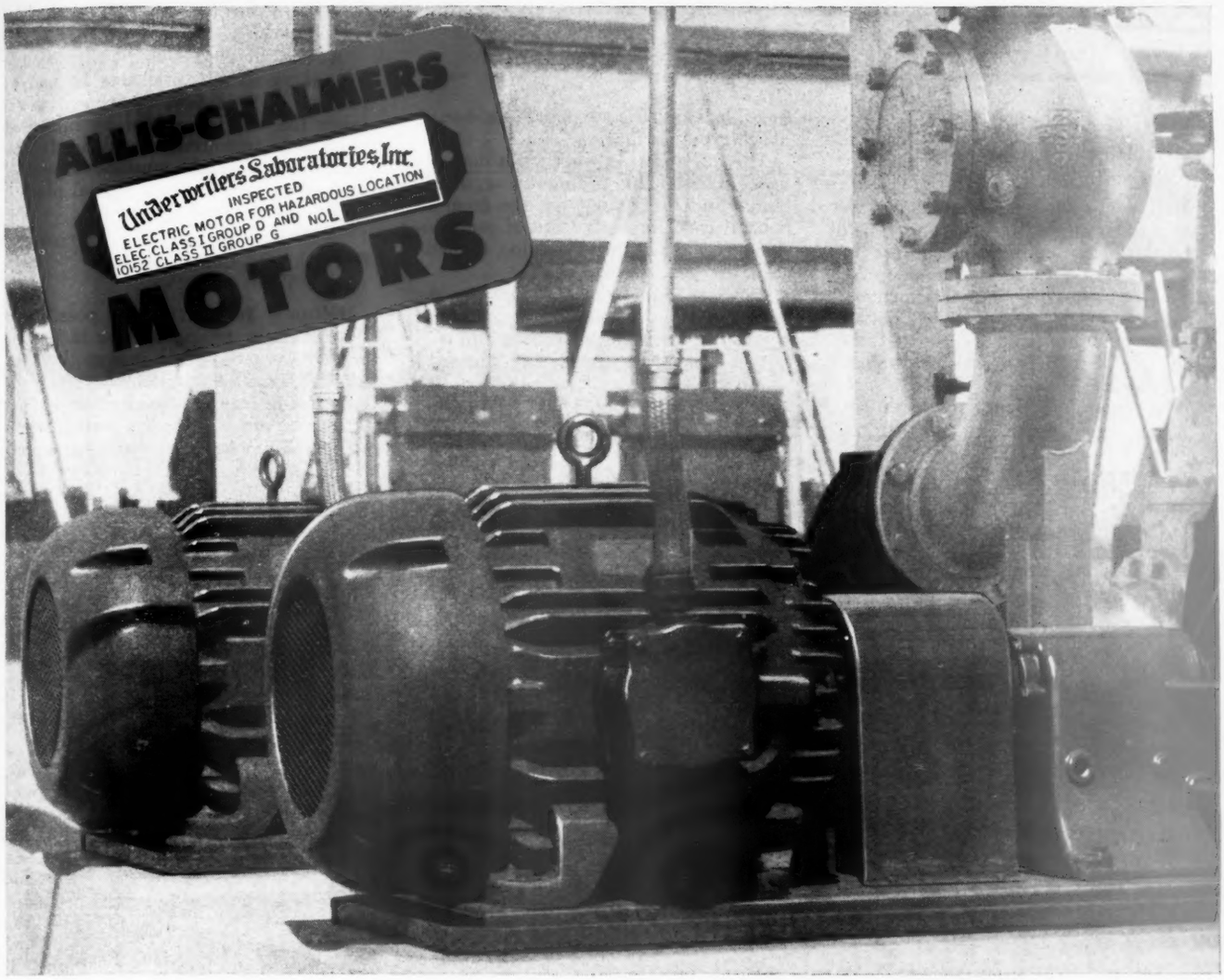
To obtain more information on products advertised see page E-59

DIAMETER, MILS,[1] OF WIRE OF VARIOUS GAUGES

Gauge number	American wire gauge (Brown and Sharpe)	Steel wire gauge	Birmingham wire gauge (Stubs')	Old English wire gauge (London)	Stubs' steel wire gauge	(British) Standard wire gauge
0000000	.....	490.0	.....	.....	.....	500
000000	.....	461.5	.....	.....	.....	464
00000	.....	430.5	.....	.....	.....	432
0000	460	393.8	454	454	.....	400
000	410	362.5	425	425	.....	372
00	365	331.0	380	380	.....	348
0	325	306.5	340	340	.....	324
1	289	283.0	300	300	227	300
2	258	262.5	284	284	219	276
3	229	243.7	259	259	212	252
4	204	225.3	238	238	207	232
5	182	207.0	220	220	204	212
6	162	192.0	203	203	201	192
7	144	177.0	180	180	199	176
8	128	162.0	165	165	197	160
9	114	148.3	148	148	194	144
10	102	135.0	134	134	191	128
11	91	120.5	120	120	188	116
12	81	105.5	109	109	185	104
13	72	91.5	95	95	182	92
14	64	80.0	83	83	180	80
15	57	72.0	72	72	178	72
16	51	62.5	65	65	175	64
17	45	54.0	58	58	172	56
18	40	47.5	49	49	168	48
19	36	41.0	42	40	164	40
20	32	34.8	35	35	161	36
21	28.5	31.7	32	31.5	157	32
22	25.3	28.6	28	29.5	155	28
23	22.6	25.8	25	27.0	153	24
24	20.1	23.0	22	25.0	151	22
25	17.9	20.4	20	23.0	148	20
26	15.9	18.1	18	20.5	146	18
27	14.2	17.3	16	18.75	143	16.4
28	12.6	16.2	14	16.50	139	14.8
29	11.3	15.0	13	15.50	134	13.6
30	10.0	14.0	12	13.75	127	12.4
31	8.9	13.2	10	12.25	120	11.6
32	8.0	12.8	9	11.25	115	10.8
33	7.1	11.8	8	10.25	112	10.0
34	6.3	10.4	7	9.50	110	9.2
35	5.6	9.5	5	9.00	108	8.4
36	5.0	9.0	4	7.50	106	7.6
37	4.5	8.5	.....	6.50	103	6.8
38	4.0	8.0	.....	5.75	101	6.0
39	3.5	7.5	.....	5.00	99	5.2
40	3.1	7.0	.....	4.50	97	4.8
41	.....	6.6	.....	.....	95	4.4
42	.....	6.2	.....	.....	92	4.0
43	.....	6.0	.....	.....	88	3.6
44	.....	5.8	.....	.....	85	3.2
45	.....	5.5	.....	.....	81	2.8
46	.....	5.2	.....	.....	79	2.4
47	.....	5.0	.....	.....	77	2.0
48	.....	4.8	.....	.....	75	1.6
49	.....	4.6	.....	.....	72	1.2
50	.....	4.4	.....	.....	69	1.0

[1] 1 mil = 0.001 in.



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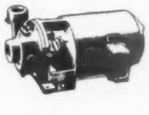

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LETTERS

Takes a Lot of Data to Find Out

To The Petroleum Engineer:

Will you referee an argument? We have a difference of opinion, in our field organization, regarding a subject on which we would appreciate an answer.

The problem: A string of tubing in a well with lower end touching bottom of hole or tubing anchor so that the lower joint is neither in tension nor compression. The well is then started producing fluids of higher temperature, possibly 175-200 F, than zones above including the surface.

The question: At what point does the lower joint of this tubing string, as the temperature increases, change from its neutral condition to a state of compression; also the status of tubing immediately above?

A: Says compression starts in the lower joint the moment the temperature begins increasing in the tubing and continues upward as the tubing temperature increases.

B: Contends expansion of tubing due to temperature increase is absorbed by tubing tension to a certain limit.

A: Asserts the lessening of tension in the tubing string could only be had by removal of weight which in turn would lower the weight exerted by tubing at point it is anchored in well head; that the removed weight must be supported somewhere and the only logical place is at the lower end of the tubing.

W. J. Grissett,
Big Lake Oil Company
Texon, Texas

Editor's Note: It is not possible to state that the tubing will be in tension or compression unless many other factors are known, for example, depth and make-up of tubing string, rates of flow, pressures, etc. A detailed mathematical calculation would be necessary, and pertinent data available.

Cathodic Protection

To The Petroleum Engineer:

We have read with interest Marshall E. Parker's article "Corrosion—An Engineering Problem," which appears on Page D-3 of your February 1953 issue. Our most sincere compliments on a fine and well-written article that should go far toward answering the objections of many who have tried their own version of "Cathodic Protection" and found that it "doesn't work." Mr. Marshall has successfully taken these most misinformed of objectors and told them some of the basic corrosion facts of life. ERP has been preaching the same word for some 17 years, and thanks to *The Petroleum Engineer* for helping to spread the truth.

Carl G. Lassen
Advertising Assistant
Electro Rust-Proofing
Belleville, New Jersey

Synthetics for Jets

To The Petroleum Engineer:

Please let me congratulate you on your recent article, "Synthetics for Jet Engines," by Arch L. Foster, Page C-3, February 1953. I found it most well written and documented.

Probably you remember our conversation in Chicago regarding synthetic lubricants. The article adds considerable water to my wheel in discussion with others.

C. W. Berger,
General Superintendent,
Refining Division,
Berry Asphalt Company

Petroleum Future

"In these times our national existence may well depend upon the availability of vital supplies here in the Western Hemisphere. We must do everything within our power to increase, rather than dull, the incentive and the initiative of the individual. What we do in that respect may determine more than any other factor, the general outlook for petroleum fuels."

Burl S. Watson, *Executive Vice President, Cities Service Co.*

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2. You can replace the clogged pipe. This again is expensive. For example, 10" steel line, 30" underground, costs at least $6.00 per foot wrapped and laid, plus the cost of tees and crosses!

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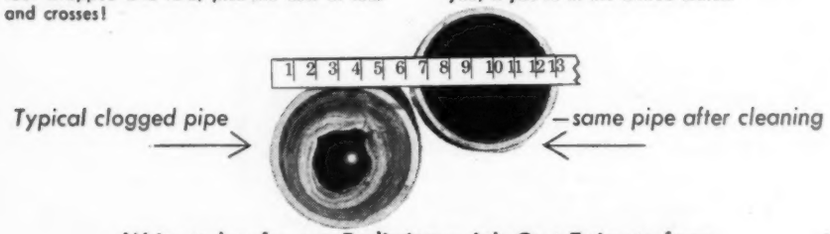

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THE Petroleum Engineer

April 1953

Notes for Oil Operators Who Need a Loan

Banks do not lend money unless there is sufficient remuneration for the risks involved; and safety factor and legality are important considerations

B. A. CUNNINGHAM, JR.

ALTHOUGH some bank loans have been made on specific oil or gas reserves in the ground in the earlier days of the industry, it is only since the time that proration became stable following the East Texas field boom that bank loans based on oil or gas in the ground has "come of age" and become increasingly important. This has come about largely as a result of the following:

(1) Bank money will not be lent unless there is sufficient remuneration for the risk. In the old days of flush open-flow at capacity from the time the well was brought in, a very large proportion of the well's ultimate production was produced during the first few months or first year of the wells' production, perhaps ranging from 20 to more than 50 per cent of its ultimate recovery. But under proration the equivalent amount of the first year's open-flow production might be spread out over several years.

Assume a bank were called upon to finance the cost of the drilling of a certain well, and that this cost might be equivalent to 20 per cent of the expected ultimate well production. The bank might be expected to receive 4 or 5 times as much interest under the spread out period of return under proration when compared to that under open-flow. Therefore, the bank might consider the total returns worth the risk under proration, but not under open-flow. Also from the standpoint of the operator, under open-flow the money came back so fast on the individual wells completed, that he was often able to pay for subsequent wells by the time they came in. Thus he stood much less in need of oil loans for development than he does now under proration, when in an active drilling campaign to protect his lease, he may be spending at a rate far in excess of the revenue from his production. Also a bank likes to have a fair idea how long a particular loan is to be outstanding and what rate payments will be paid. Under allowable rates of production, this can be much more definitely determined.

(2) During the past 20 years proration has become accepted and stable. For this reason there is not so likely to be the "feast or famine" periods in the industry and a much more stable price structure results. In turn a bank feels more confident on the price structure used in estimating the values and so is more willing to lend.

(3) During this same period there have been great technical advances in the methods and means of determining recoverable reserves and this extra surety makes the banks more willing to lend on this type of security.

(4) Under the impact of higher and higher taxes over the past years, it often becomes necessary for the operator to sell on a capital gains basis for him to realize the true value of his property. Thus, there are a large number of sales and purchases taking place for this reason, which has created a tremendous demand for bank loans for this purpose. Through bank loans, the independent operator can buy as well as sell properties and not be merely dependent on a well-financed major company to be able to purchase the property. Ten to 15 years ago, the majority of the loans both in number and total dollars were for development, and although there have been many development loans over the last few years, the greatest amount of dollars is going into purchase or sale deals.

Requirements of a Bank Loan

A bank loan on oil and gas reserves in general must meet satisfactorily three requirements: (1) safety factor, (2) length of payout with interest, and (3) legality.

(1) "Safety factor" may be defined as the ratio of the discounted present worth of the reserves to be used divided by the desired loan. The discounted profit from the reserves should be used, and not the mere future net profit in determining the necessary safety factor, for the bank must get back the money lent with interest and not just the principal itself. This is actually included in the discounted value of the future net. A loan is bearing interest as soon as it is made and, if the rate of return is too slow, the return might not even take care of interest, and thereby reduce the principal in a reasonable time. The

The Author

B. A. Cunningham, Jr., is vice president in charge of the appraisal engineering department of the Republic National Bank of Dallas, Texas. A graduate of Cornell University, Cunningham began working as a roustabout in the Breckenridge field in 1921, immediately after graduation. For the following 15 years he held different positions in the production and engineering departments of the Pennok Oil, Simms Oil, and Tide Water Associated Oil Company. For the last 17 years he has been in appraisal engineering work for the oil loan department of Republic National Bank, becoming head of the engineering department as it expanded. He was named to his present position in 1948.

EXCLUSIVE

reserves that should be used will be discussed later in detail. The minimum "safety factor" to be used should not be fixed for all cases, though in general it might be said that it should not be less than 2:1 and should range up from there. The desired minimum safety-factor on the particular loan should be recommended by the engineering department to the loan officer. The recommendation depends on a number of factors:

(a) Diversification both for leases and fields. This is based on the old law of averages. Although it is quite possible that the engineers may have their estimates too high on one lease or field, they may be too low on others, so that on a number of fields there is quite likely to be a truer average struck on the total. But if only one lease or field is up as collateral and the estimate or ideas on this prove wrong, it could easily be that the loan might turn out to be a poor one. Thus the greater the diversification the less need be the minimum safety factor. We might state here that as a general rule a bank will not lend money on one well, or sometimes on several wells if one of them has a disproportionately large value. This is due to the fact that something mechanical or otherwise might happen to the one well and the loan could not be paid out. With a good safety factor, however, the remaining well could finish paying out the loan even if something happened to the one well.

(b) Knowledge of the field or fields. For example, a loan in the East Texas field on which the history and data are so well known would not require such a safety factor as a new field on which data are lacking.

(c) Reliability and amount of data on which evaluation of reserves is based. In each case the engineer will of course give to the best of his ability the estimation of reserves. In some cases, however, the data on which this is based is necessarily sketchy, while on other cases there is a wealth of data available, such as core analysis, P-V-T, bottom hole pressure history, etc.

Thus it can be seen that the minimum required safety-factor should not be a fixed figure, but should vary with the character of the collateral offered, although it should probably very seldom be less than 2:1.

(2) The second major requirement that the collateral must meet besides the necessary safety-factor is a satisfactory length of payout with interest. A bank is lending largely on demand deposits and a bank cannot afford to have too large a proportion of its deposits tied up for too long a loan period regardless of changing conditions. It is most often the case that a satisfactory safety factor automatically gives a satisfactory length of payout. But in some cases the length of payout is the determining factor as to the size of the loan, as where the reserves are very large in proportion to the allowable production. As an example of this type is a well-located lease toward the high structurally east side of the East Texas field.

(3) The third major requirement is of course self-evident: that the collateral required must satisfy the legal requirements, and the borrower have good title to the properties and be able to pledge them.

Mechanics of Oil Loan Banking

In a small or inactive bank in the oil loan business, the prospective loan would be handled by a general loan officer and on a report prepared by a consulting engineer or geologist.

In a large and active bank in the oil loan busines, this phase of the business is extremely important and a large and specialized department has been set up to care for it. This department has three major divisions. These divisions are (1) loan officers, (2) engineering, (3) collateral and accounting. The functions of these three main divisions are as follows:

(1) *Oil Loan Officer Division.*

This may consist of one loan officer who is most familiar with the handling of oil loans in a less active oil loan bank, while in others there may be a number of oil loan officers who direct their full time to the bank's oil loan business. This department has charge of customer relationships and make most of the direct personal contacts with customers. The members interview the new customers and also confer with the old customers about possible changes in revamping their loans. As a general rule the oil operator's business is not static, so that likewise his oil loan needs are not static, and very often the way the loan was set up originally will not now fit into his picture. Thus he may need new money for a drilling campaign, etc.; or, on the other hand, he may want to sell off some of the leases under the collateral and wish to see how much of the sale price need be applied to satisfy the loan requirements of the bank. The bank realizes these changed conditions can take place and should always be ready to discuss a possible revamping of this loan. A very large part of the continuing oil loan business of a bank comes from such revamping of loans, the giving of new collateral and the releasing of other.

Assuming it is a new customer applying for an oil loan, he will first discuss his general problem with a loan officer concerning amount of loan desired, collateral to be offered as security, desired method of repayment, etc. From this preliminary discussion the loan officer from his general knowledge, or after perhaps a brief review with the engineering department, decides whether the loan would have enough merit to justify a full appraisal by the engineering department. They can thus weed out a large number of applications that can be seen not to satisfy the requirements of a bank loan, and thus save the engineering department work that will not prove productive of a loan at the end.

If it now appears that the requested loan may be satisfactory, it is turned over to the engineering department for appraisal. The work of this department will be taken up in detail later. After the appraisal report has been prepared, it is discussed with the loan officer who decides on this basis (sometimes in consultation with the head of the department or president of the bank, depending on the circumstances or size of the loan) whether or not to make the loan and on what basis. At times it may be settled for a smaller amount or on different payout basis than originally discussed, depending on the findings of the appraisal.

The conclusion is then discussed with the customer and if mutually agreeable the loan commitment is made subject to legal requirements. The proper title to the collateral must be determined by a legal firm and its title opinion is considered by the loan officer and either approved or disapproved. If approved, a deed of trust is drawn up giving the bank a lien on the property and usually an assignment of the runs, although this is not always the case. In some instances all runs are assigned to the bank and then the agreed upon distribution made by the bank to the loan and customer account. On the signing of the deed of trust and note, the amount of the loan is applied to the customer's account or to whatever is designated. The collateral, loan agreement, etc., are then turned over to the third main division of the oil loan department, the "collateral and accounts" division for further handling, the functions of which will be discussed later.

(2) *Engineering Division.*

If it appears to the loan officer that the application has sufficient merit to justify an appraisal by the engineering department, it is then turned over to them for such an appraisal.

The work of the appraisal engineering department requires a knowledge of both geology and petroleum engineering, but the preponderance of the work is engineering as the loans are made on the proved and developed reserves where the geology is already more or less defined.

Although some banks do not, it has been found extremely important to make an inspection and test of all working interest leases that may be part of the collateral. This inspection brings such data right up to date and is also correct. It has been found that such data as provided by many operators are non-existant or sketchy and are sometimes rather biased. In this inspection trip the engineer makes a general survey of the leases in question concerning their equipment and method of operation. The loan is made largely against the discounted present worth of the reserves and not the equipment. It is necessary, however, to know what is installed such as tanks, pumping equipment, etc. It is also necessary to see if it is sufficient, and satisfactory to carry the lease to depletion or, whether it is necessary to deduct with the lifting expense, the cost of such additional equipment as needed. Observations can be made as to whether the operations appear to be satisfactory and efficient to deplete correctly such reserves. Information can be gathered on the number of men employed, the number of pulling jobs, etc., as a check on the operating expenses in the evaluation.

On such a trip, a productivity test is made (usually on each individual

well, if justified) to estimate its true potential, the amount and per cent of water, gravity of the oil, and gas-oil ratio. It is determined whether bottom hole pressure tests and productivity index tests are necessary. If so, these are run by engineering firms that render such service. Records are made, of course, on operating conditions such as chokes, flowing pressures, line pressures on gas wells, etc. If such data are not available it is sometimes found necessary to require certain other data to be taken such as additional core analysis, gas analysis, viscosity, compressibility tests, etc.

The engineer also acquires additional knowledge of the field as a whole with its problems. Perhaps he talks these over with other engineers or operators in the field, and obtains from them certain test data and analyses that had not been presented by the operator when applying for the loan.

In a good many areas there are field engineering committees that have compiled data on the field operations. Their reports are very valuable and time saving in making up the appraisal.

If they have not already been provided, the engineer gathers up all such records on the leases in question such as completion data, electric logs, analysis that may have been made, production and run records up to date, operating costs over the preceding period, etc. The operator provides also, of course, his per cent working interest in each lease, the amounts of the royalty, and overriding royalties and oil payments, if any. If he only has part of the working interest in a lease, the names of the partners and operating agreements are also given. The price received for the crude is substantiated if necessary, and on gas wells a copy of the gas contract is provided.

After the tests are made and all possible data compiled, the actual appraisal is made in the bank quarters.

Usually, the first step in the appraisal is the preparation of maps, such as ownership, structual, isopachous and sometimes isobaric or some other types as cross sections and so forth.

Type of oil or gas reserves. The question then comes, what type of oil or gas reserves should be used in making the appraisal of present worth value on which the loan will be based.

Most lending institutions use only the present proved and producing reserves that can be recovered from the existing producing wells. This is not always a hard and fast rule as circumstances vary, particularly where the loan involves the purchase of a property. This is especially the case where the expected reserves not yet developed are high in proportion to the development costs of drilling additional wells.

The reason for this general rule outside of the fact that on apparently proved areas the wells when drilled may actually come considerably different from what was previously estimated is shown by two types of examples:

(1) Suppose a 160-acre lease was apparently entirely proved and had only two wells at that time, but that a total of 4 was required to complete development. Also assume in this case that reserves for 40 acres justified lending the drilling costs of a well. Now if the full reserves on the proved 160 were used in estimating present worth and the maximum loan made on this basis, the operator might use the proceeds of the loan for other purposes, so that when the time came to drill the other two wells, he would not have the money to drill them. The bank would then have to lend him additional money to drill them to protect the lease and loan and recover the estimated reserves. But as the existing loan already takes these reserves into consideration, the new loan for drilling the required wells to protect the reserves would thus constitute an overloan on the lease.

(2) A second type of example is lending on oil reserves behind the pipe or, perhaps, below the currently producing horizon. It is possible that before the wells, on which a loan is being sought, in a producing zone have reached their economic limit and the other zone ready to be exploited, this new zone has been found to be already largely depleted by outside wells in the field that may have found the main producing horizon dry or became earlier depleted in it. Also, of course, as these non-productive horizons could not be tested at the time of the appraisal, there would be much more chance for error in trying to determine these recoverable reserves and present worth value.

There is also the question, which is becoming increasingly important on whether to consider the reserves for primary recovery only or to add also for secondary. This is not a hard and fast rule, but in general, only the primary reserves are used. This would, of course, depend on the circumstances and the amount of engineering data on any flooding and unitization that has been done.

Recoverable Oil Reserves. The actual estimating of the recoverable oil reserves is usually based on two general methods, and these often intertwine. Sometimes they can be used to check one another. These methods are: (1) Decline curve and (2) volumetric.

(1) *Decline Curve.* The production decline curve method is usually not available during the development period when the wells are new and produce under proration. Even if at capacity, they have not been producing sufficiently long to determine a definite decline curve. The longer the period of decline the more accurate is likely to be its extrapolation. Production by months or years is plotted on either log—log or semi-log paper, whichever fits the particular decline against time, and this curve is extended into the future to the economic limit. The production curve alone without other supporting data, however, could often lead to the incorrect interpretation. For example, the apparently slow decline may be due to reworks, reacidization, hydrafrac jobs, etc., and when the effect of this flush wears off the slope of the curve may change materially. It must also be considered in relation to the development of the field as a whole and what other data are available. For example, earlier wells in a field at capacity may decline at a much slower rate in their early life on account of their drawing on the field as a whole, but when interference is set up by subsequent wells, then decline curve may show a sharp "dogleg." Often other data are available to help predict the trend of the curve. For example, in the earlier days of the Spraberry many wells at capacity were declining on smooth slow log-log decline curves that if extended would give good recoveries. The first pressure survey indicating low pressures on new wells at considerable distances from older production, however, indicated long effective drainage areas and as soon as interference set in the change in slope would be drastic, and the actual recoveries low. Also, it must be taken into consideration the type of drive, for the slope of this curve may be expected to continue to the economic limit on solution gas drives; but on a water drive

Resources for Future Gets President's Support

Following an exchange of letters between President Eisenhower and Horace M. Albright, Resources for the Future, Inc., announced it has called a national meeting of a Council of Sponsors to review plans for the forthcoming Midcentury Conference on Resources for the Future. This preparatory meeting will be held in Washington April 20, 21, and 22 to establish final plans and to issue the call for the conference.

Albright is president of Resources for the Future, a non-profit corporation, devoted to the support of research and education in the field of resource conservation and development. The corporation has received a grant of $150,000 from Ford Foundation to prepare for and conduct the conference on future resources.

Resources for the Future has invited, as members of the Council of Sponsors, a group of national leaders of public opinion to emphasize its feeling that resource and conservation problems are of concern to all citizens' groups. Those asked to serve are heads of some 40 national organizations representing a wide cross-section of business, labor, and agricultural groups; education, conservation, and scientific organizations, and citizens' associations that have a direct interest in the conservation and development of the nation's natural resources.

President Eisenhower assured the sponsoring organization of continued assistance of his Administration.

XUM

the well may suddenly go to water on the water level reaching the well, or at the other extreme, if there is a gas cap it may expand and the well go rapidly to gas. Also on a decline curve when the drive is due to gravity drainage, the curve slope may dog-leg as the oil drains on down dip.

Besides the common production vs time curves, other decline curves that may be a help in determining reserves are decline in bottom hole pressure curves vs production both before and after the bubble point is reached. Cumulative production plotted on log-log paper against drop in bottom hole pressure is often indicative of the ultimate recovery and the type of drive, particularly on a field basis. On a well producing water, the per cent of oil in the fluid plotted against cumulative production is also often of value in predicting.

In estimating gas reserves by the decline method of production vs decline in bottom hole pressure, care must be taken also to take into consideration type of drive and the supercompressibility factor. Also, of course, in gas distillate fields the factor of retrograde condensation must be estimated.

(2) *Volumetric method.* Under proration and with development loans a larger proportion of the bank appraisal estimates necessarily fall under this category. Of the greatest aid in this are various electrical logs, the radioactive log, drilling time log, etc. These are coming more and more into common use and some are almost a necessity in certain areas. To these, of course, can be added core analyses, gas analyses, and test data such as bottom hole temperatures, bottom hole pressures, gas-oil ratios, bubblepoints, viscosity measurements, and permeability relationships. It is true, however, that on many estimates a large percentage of these basic data is lacking, which is particularly true on reliable estimates of connate water. These basic data for determining oil or gas in place can sometimes be checked by field performance data such as declines in pressure vs production and material balance calculations.

After the estimation of the oil in place from the data available, comes the determination of type of drive and per cent recovery. Very often in making the appraisal estimates, particularly in the early development, the type of drive cannot be definitely determined and reliance must be placed on comparison with types of fields of like nature in this same area where such have been determined. Once the type of the drive is determined, the percentage recovery to be used can then be decided. In addition to the old rule-of-thumb methods, formulae, and correlation charts can be used to help the estimate by inserting the basic data available or estimated, that would influence such percentage recovery. On fields further down the line in depletion, the data on the wells or field itself may help in this determination.

Although true decline curves cannot be constructed before capacity production is reached, the potential and production history of the wells can often be used to make estimated normal decline curves as a cross-check against volumetric calculations. Such data are useful in determining possible rates of decline when at capacity and length of future life as these are integral parts in determining the present worth.

Then, of course, the structural position and relation of the lease to density and recovery of the field as a whole, as well as the type of proration formula, must be taken into consideration. Often the oil in place and its per cent of recovery bear little relation to the expected recovery of the well or lease in question and may be considerably higher or lower. A good example of this is a well situated high structurally in the thin sand section in a good part of the East Texas field on small acreage. The recovery of this well may be several hundred times higher than the recoverable oil in place.

Future Profit. After the ultimate recovery is estimated, the future recovery is obtained by subtracting the past production to the date that the loan would become effective. From this future gross recovery is found the future net barrels by multiplying by the percentage of the working interest taking into consideration royalty, overriding royalties, and oil payments, which in some cases act as overriding royalty. These future net barrels are then multiplied by the price, to determine the future gross revenue. In the case of oil, the current posted price is generally used, while in the case of gas the price used is that as determined by the contract under the expected rates of recovery as these prices are often variable, usually rising over the future.

It is usually more simple to subtract severance taxes from the regular posted prices in determining future gross revenue as that gives what is actually received. From this future gross income must be subtracted the operating costs over the future. As a rule, general office overhead is not taken into consideration as this could be almost anything in relation to the lease. Rather than use operating costs at so much per barrel, the bank has found it is much more satisfactory to use the estimated future life by months and then estimate the average labor, material, pulling costs, etc., to make up the monthly costs over the future. To these lifting costs must be added the possible major equipment expenditures if necessary, such as pumping equipment. To these should be added major remedial jobs if thought needed such as plug-backs or workovers. Also to be included would be ad valorem taxes, which may be the only item if the interest valued is a royalty. If oil payments remaining have not already been deducted to obtain future gross revenue, they should be deducted here.

Present Worth. The future net profit is discounted annually to determine present worth, such as a 5 per cent discount factor compounded annually. For this, it is necessary to estimate the future profit for each year and multiply this by the discount factor for the particular year to obtain the discounted present worth for that year, the summation for which would give the present worth of the lease for its future life. In other cases, where the production and expenses are expected to remain the same for a large number of years, an average discount factor for the life of the lease can be used.

Monthly or Yearly Income. This is estimated to determine present worth as discussed above and also to estimate for the bank the length of payout plus interest on any given loan, and this latter is often a determining factor in deciding the size of an acceptable loan as was discussed in the early part of the article under the second requirement of a bank loan.

Safety Factor. This is the ratio of the summation of the discounted present worth of the properties to the desired loan, and was also discussed in the article as the first requirement of a satisfactory bank loan.

Appraised Report. After preparing all the data for determining the factors discussed above, a formal report is usually written giving the pertinent data with maps. This is presented to the loan officers, along with verbal consultation, to determine whether a loan should be made; and to be placed in the bank files as the supporting data for such a loan for the bank itself, and later for the bank examiners if necessary. If a participation is made in a loan with another lending institution, a copy of such appraisal report is sent also to the participating institution.

Under the conclusion of the appraisal reports is given the summation of the engineer's ideas and recommendations as to necessary safety factor, payout, and method of payments for a loan of satisfactory size on the collateral offered.

(3) *"Collateral and Accounts" Division.*

This division of the bank comes into play on the oil loan assuming an agreement is reached and the loan consummated.

When the loan is closed the legal instruments involved, such as the deed of trust, legal opinion, etc., are turned over to this department. They have charge of the collateral for each loan and are responsible for the legal recording of the loan papers, notifying the pipe line companies, signing the division orders, and that the proper funds are being paid into the bank. Collateral sheets are set up for each lease and monthly are posted the gross runs and the amount received from the lease both for accounting purposes and to allow the engineering department at any time to appraise how the individual lease is doing. After posting, the run statements from the pipe line companies are attached to the pipe line checks and turned over to the bank's loans and discounts department who credit the funds against the loan in question, according to the instructions furnished. The run statements and records of the payments, etc., are then mailed out to the borrower. * * *

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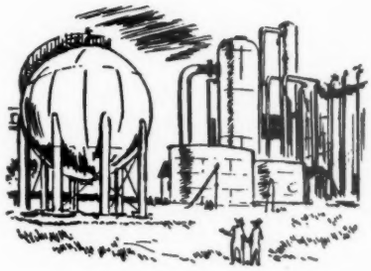

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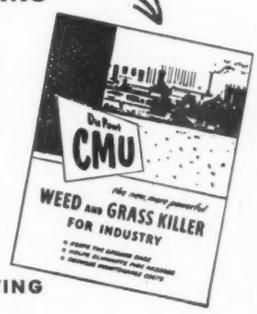

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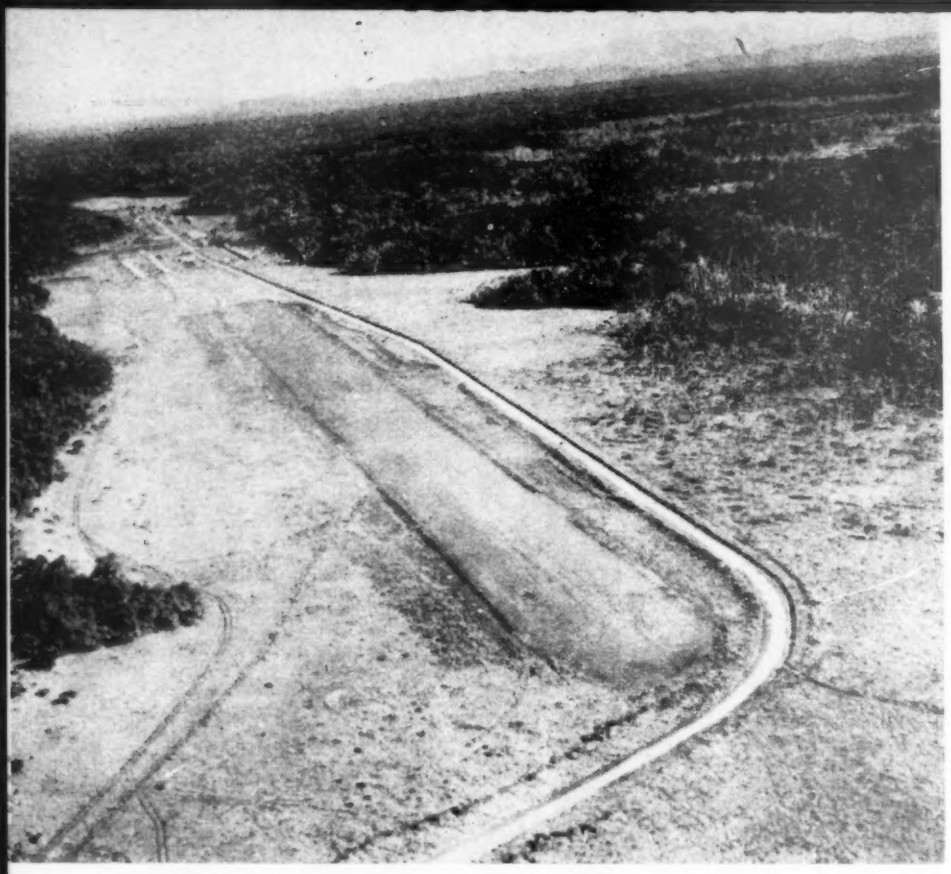


An airstrip and road carved out of the virgin jungle in Papua to assist supply lines for the drilling areas.

IS THERE ANY OIL IN THE FIFTH CONTINENT?

Millions of dollars have been spent, and more will be spent in the continuous search for oil in Australasia

E. G. NOTTES

THE main continent of Australia has to date no commercially producing oil fields. But the great island of New Guinea, the northern Bastion of the fifth Continent, has already yielded an output of about 4000 bbl of oil per day in its western part. The search for oil has continued for a number of years in various areas and recently the activity of the Australian Commonwealth and state governments and the oil companies has been increased.

Exploratory wells have been drilled in 8 of Australia's 14 sedimentary basins. Two of these basins (Roma and Lakes Entrance) had good showings of oil and gas, but active drilling has been disappointing.

There are, however, some geologically favorable conditions especially in Western Australia. The huge expansion program of Australia's refineries now going ahead gives a great stimulus to the search for oil. A fast growing population should also provide a good market.

The steadily increasing capacity of the Commonwealth's basic steel industries can provide a valuable support to all these activities.

Foreword

Australia, the fifth and, geologically speaking, the oldest continent of our world, has still no commercially producing oil fields. A huge and costly refinery expansion program under way, and involving the joint expenditure of more than £A80 million ($180,000,000). will enable Australia to refine nearly all her fuel requirements within the country in the next few years. The crude oil for these refineries will need to be imported over long distances unless local fields of adequate size are found.

EXCLUSIVE

Historical

Only commercial production of gasoline and by-products from Australian sources has been made from oil shale.[1]

Oil shales with the richest known kerogen content occur in Australia,[2] but under present circumstances mining costs are too high. This was one factor at Glen Davis, N. S. W., that prevented the only Australian cracking plant built to date from working economically in competition with imported petroleum products on the open market.[3]

Often the opinion is expressed here "The rocks in Australia are too old to contain oil," or even the ridiculous statement is made—"Oil has been discovered but certain interested foreign circles have had the discovery hushed up."

But the latter statement cannot stand up against the fact that the equivalent of $40,000,000 has been spent in the search for oil in Western New Guinea and several millions in the eastern part of this great island which is so close to the Australian shores.[5]

For instance, for 1948 the following activities were registered[8] in crew months:

	Australia	Papua/New Guinea
Seismic surveys		2
Gravity surveys	8	12
Magnetic surveys	8	6
Geological surveys	56	70

To date more than $4,500,000 have been spent on the Australian mainland where about 300 wells have been drilled, and many thousands of square miles have been surveyed. On the mainland[4] of Australia the results have been poor from a commercial point of view. Small amounts of natural gasoline have been obtained at Roma, Queensland, and only small quantities of crude oil were found in the State of Victoria.

For more than 50 years, many private enterprises and various State and Federal Governments have made long and extensive surveys and searches for oil in the country.

There has been some activity in New Zealand, but no reward in the form of

The Author

Ernest G. Nottes, F. Inst. Pet., is refinery superintendent of the Dubbs cracking plant and refinery at Glen Davis, New South Wales. He was graduated in chemical engineering at the Technical University, Vienna, where he also obtained his Doctor of Science degree in 1935. He worked several years in the field of fuel synthesis from coal, tars, and petroleum oils at Leuna works, and was also in charge of the hydroforming plant, and did research on Fischer Tropsch derivitives and other petrochemicals at Leverkusen on Rhine. One of his processes concerning phenols recovery from hydrogenation oils is established in some coal hydrogenation plants.

PHOTOS COURTESY PETROLEUM INFORMATION BUREAU (AUSTRALIA)

commercially producing oil wells has been obtained so far.

Considering her great wealth in black and brown coal deposits per head of population, Australia appears to be at the present time, one of the most fortunate countries in the world for fuel supplies. The industrial development has not yet reached a stage where synthetic fuels production either by Fischer Tropsch or high pressure hydrogenation has progressed beyond that of the initial.[a]

The increase in the steel and open-cut coal production, which has lately been achieved, can together with the large refinery expansion program give a sound basis for both alternatives: Exploring and drilling for oil, and sooner or later perhaps fuel synthesis from coals, if required.

Drilling in New Guinea

The first commercial success in the Australian sphere has been achieved in the Dutch part of New Guinea north of Australia.[5]

The first barrel of lubricating oil manufactured in the Australian refinery of Vacuum Oil Company from more or less indigenous crude was filled by the Minister for Supply and Development, on February 20, 1950. The crude oil for this product came from wells in Western New Guinea.

By February, 1939, a well was commenced at Klamono.[b] Fourteen wells were drilled, of which eight were productive when the war broke out. Activities were renewed in 1946, and in 1948 the first shipment was made about December. Soon the production had increased to approximately 4000 bbl per day.

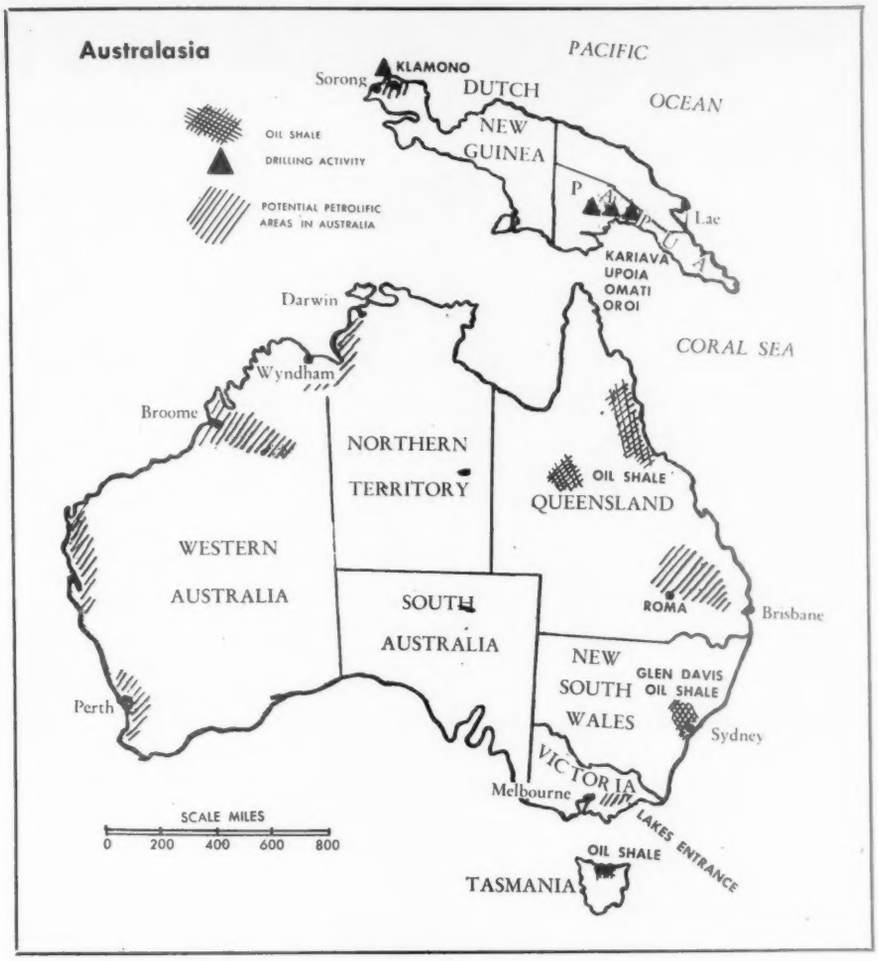
The crude oil contains a large amount of fractions that are suitable for the production of lubricating oils, and bitumen. The percentage of light fractions in the gasoline and kerosine boiling range is low.

Since 1936, the Island Exploration Company Pty. Ltd., a combined enterprise of British, American, and Australian interests has surveyed roughly 20,000 square miles in Papua and about the same area in the Mandated Territories of New Guinea. Another concern working in the same area and of the same international composition, is the Australasian Petroleum Company. Upwards of $22,000,000 (£A.10,000,000) has been spent on exploratory drilling, surveying, and testing in Eastern New Guinea.

The surveys were made by a combination of aerial and geological-surveys. The test wells of APC at Kariava, Oroi, Upoia, and Wana have been abandoned. The Island Exploration Company, however, drilled a well at Omati. This test

[a]According to newspaper reports, the State Government of Queensland had recently consulted some overseas experts as this state has large deposits of high grade coal that is suitable for fuel synthesis.

[b]See map.



Camp at Wana, Papua, under construction. Only transport is a narrow gage railway from store houses to derrick being built in background.

THEY LICKED A TOUGH PROBLEM in

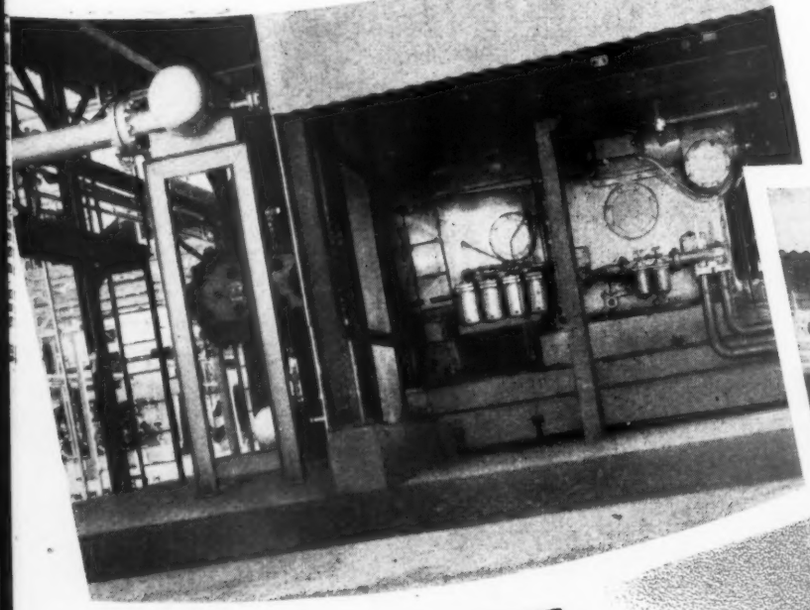
with Cooper-Bessemer

THE two GMV's shown here operate as recycle hydrogen compressors for the remarkable new Platforming and Udex units in the Houston refinery of Eastern States Petroleum Company, Inc.

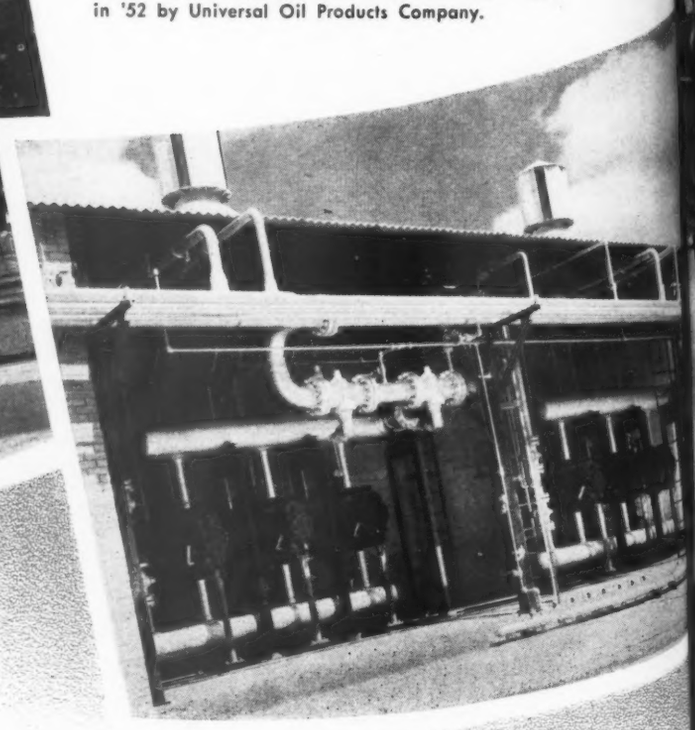
In this processing it was particularly important to avoid contamination of the recycle gas. To solve this problem, Cooper-Bessemer successfully developed *non-lubricated compressor cylinders* with light carbon pistons and segmented carbon rings. Moreover, cylinder bores were honed to a mirror finish of 4 to 6 micro inches. Now, after thousands of hours of operation, checks show no excessive wear anywhere.

If you have a similar problem, or compressor requirements of virtually *any* type, you'll find Cooper-Bessemer ready to cooperate . . . as usual . . . all the way.

End view of one of the GMV units showing method of separating engines and compressor cylinders.



As shown in this view, each 600 hp GMV drives 3 compressor cylinders, all of special non-lubricated design to avoid gas contamination. Eastern States' Platforming and Udex units, for which these GMV's handle recycle hydrogen, were put on stream early in '52 by Universal Oil Products Company.



ANGLE

Compressors

New York Washington, D. C. Bradford, Pa.

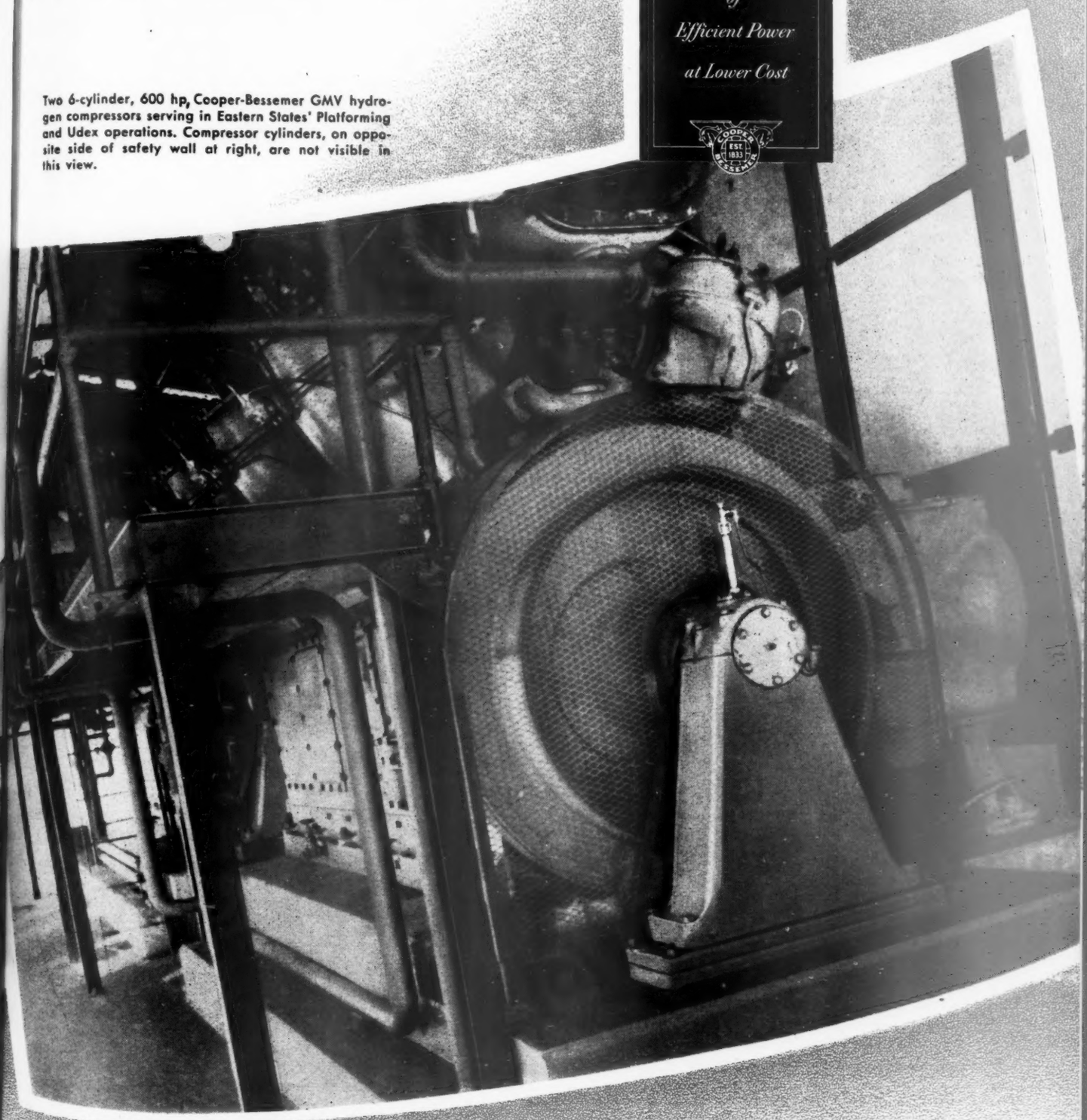
San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash

in Eastern States' Platforming Unit

GMV's

Another Example of Efficient Power at Lower Cost

Two 6-cylinder, 600 hp, Cooper-Bessemer GMV hydrogen compressors serving in Eastern States' Platforming and Udex operations. Compressor cylinders, on opposite side of safety wall at right, are not visible in this view.



by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Tulsa Shreveport St. Louis Los Angeles Chicago

bore has been deepened to 9355 ft recently.

Some of the difficulties encountered in the jungles of New Guinea are transportation problems, lack of suitable labor and the tropical climate. As many parts of New Guinea, and especially the inland, have yet to be explored more thoroughly, the search for oil continues. In the meantime, however, the Australian Continent has also seen some activity.

Drilling in Australia and New Zealand

Generally speaking the areas that show sedimentary basins containing marine rocks of Cambrian and younger age are listed as follows:[9]

Queensland	:	The great Artesian Basin
New South Wales	:	Coastal Sydney Basin
Victoria	:	Gippsland Basin
South Australia	:	Murray Valley and Eucla Basin
Western Australia	:	Coastal plains, North West Basin, Bonaparte Gulf and Kimberley Basin.

Vacuum Oil Company stated that it has spent already more than $8,500,000 (£A4,000,000) in its attempts to find oil in Australia and New Zealand.[6]

The Commonwealth Bureau of Mineral Resources has recently completed an aerial magnetometer survey in Victoria at Lakes Entrance and is making surveys in Western Australia.

Thousands of feet of casing pipe are stored at Badilli, Papua, waiting shipment to various drilling sites.

Victoria. Lakes Entrance in the State of Victoria has seen much prospecting in earlier years. Peddal drilling from the bottom of a 1200 ft shaft had resulted in the production of a small flow of crude oil.

Oil has also been found in small quantities in glauconitic sandstone of Middle Miocene age at depths of 1000 to 1400 ft.[9] The average thickness of the sandstone is 30 ft. Oil occurs in three horizons within the sandstone in a series of stratigraphical traps. The quality of the oil is reported to be of a naphthene base type. The gasoline and kerosine fraction is absent. It contains a large amount of lubricating oil; sulfur content is low.

All in all, since 1924 about 50 bores were drilled in this locality and something like $400,000 was spent without great commercial success.

Queensland. In Queensland long before the first world war, a bore was drilled at Roma to supply the township with water. Gas was produced in such quantities that a gasometer was built and even street lighting was installed. Two weeks after the street lamps were lighted, the gas supply stopped abruptly!

It is believed that the small amounts of oil that have been found in the Mesozoic rocks of the Roma area have migrated from the underlying Permian beds.

Outcrops of Permian rocks to the

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The Pelican 2"	**Weight**	**70 lbs.**	**7500 G.P.H.**
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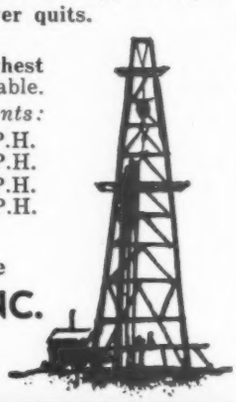

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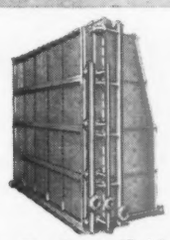

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north of Roma have been found. Oil Search Pty., Ltd., was able to drill two holes on each of the two domes in this area. One of them, the bore at Hutton Creek, entered steeply dipping and sheered sediments at a depth of 4080 ft. It was finally abandoned at a depth of 4688 ft.[7]

Shell (Queensland) Development, Ltd., has spent more than $2,200,000 (£A1,000,000) in the search for oil in Queensland since 1940.[8] Some of their activities also extended recently to drilling a deep well at Morella, 100 miles south of Springsure. The equipment was suitable for drilling to a depth of 10,000 ft.

In 1951 four Australian companies have merged to drill for oil near Roma. A nominal capital of $2,500,000 is said to be available. Drilling was recommended by Queensland Government geologists, and mobile drilling equipment has been bought.

South Australia. In South Australia a subsidiary of D'Arcy Exploration Company, Vacuum Oil Company, and the Zinc Corporation was searching for gas and made magnetometer and gravimeter surveys in the Lake Frome area. Drilling in the northwest of Broken Hill was also undertaken by the same Company.

Western Australia. 1. *Coastal Plain Basin:* The American oil geologist, F. Reeves, has suggested in his study of oil possibilities in Australia[10] that in a coastal strip around Perth, an area of roughly 5000 square miles has geological conditions favorable for the presence of oil.

2. *The North West Basin:* The Bureau of Mineral Resources has made extensive surveys in an area that covers 450 miles length by about 100 miles width, near Exmouth Gulf. A joint company formed by the Caltex and Ampol Petroleum Companies, with a capital of more than $2,200,000 is bringing out heavy American equipment, and will commence drilling soon.

It has been stated that the new company will work under the supervision of Caltex, which will hold 80 per cent of the interests. The remaining 20 per cent is owned by Ampol Petroleum Company of Australia, Ltd. All in all, it is intended to spend $3,300,000 searching for oil in Western Australia by this company in the next 12 months.[11]

The area contains fossiliferous rocks of Tertiary, Mesozoic, and Paleozoic age with good structures. It is considered by Ampol to be an attractive potential area from the geological point of view, and the potential production zone is estimated to be as deep as 18,000 ft.

3. *The Kimberley Basin:* Authentic traces of oil have been reported from the Kimberley district of Western Australia. A thick series of Permian rocks with underlying Devonian beds occur in this Basin.

Shortly after World War I, asphalt was detected in limestones at the junction of the Ord and Negri rivers. Although several tests for oil have been carried out unsuccessfully[c] recently the search was renewed. Government and

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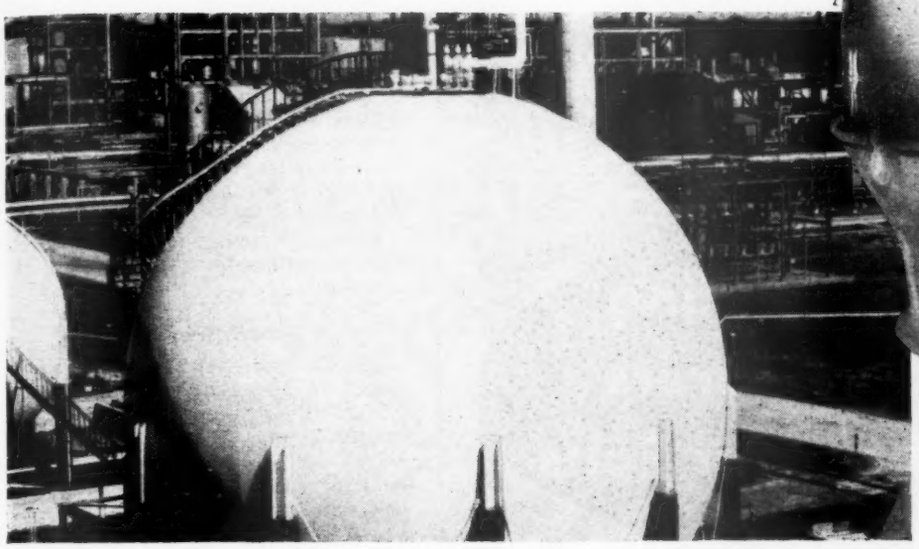

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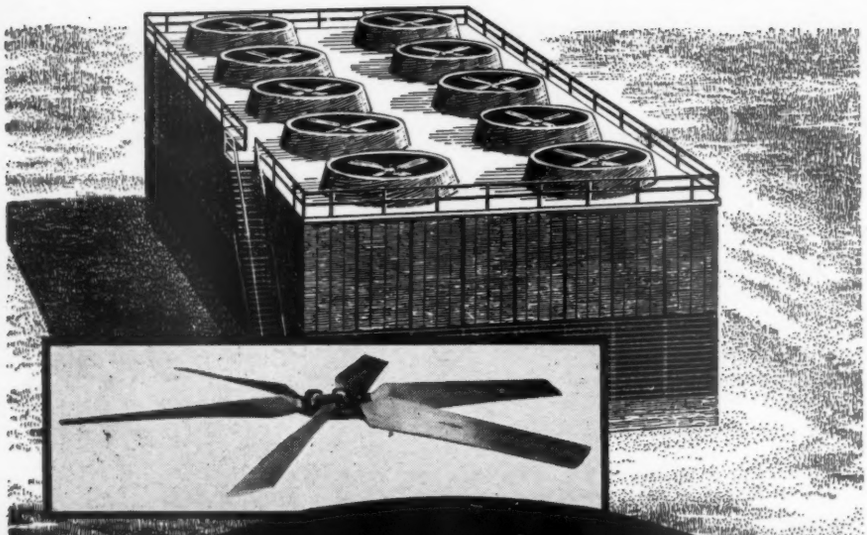

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private enterprise are now negotiating to form a syndicate.

4. *Bonaparte Gulf Basin:* The Ampol Company has taken up lately prospecting permits on the coast between Wyndham and Port Darwin. Geological surveys were made earlier.

Certain geological factors that are considered to be necessary to the accumulation of oil are seldom found in Australia.[10] There are, for instance, only few sedimentary basins with a fair thickness of marine sedimentary rocks in unmetamorphised state. It should be borne in mind that many of these sedimentary basins have also been subjected to erosion and aridity and general conditions, which are not conducive to the occurrence of seepages. A few of the basins on the coast of Western Australia, however, show very favorable conditions.

It can be expected that they may contain oil and will be tested soon and extensively.

Future Prospects

All the major oil companies represented in Australia including Vacuum Oil, Shell, Anglo-Iranian Oil, and Caltex, have actively participated in the search for oil. With the aid of most modern methods, and with large scientific and technical staffs, and up-to-date heavy equipment the search for oil continues in Australasia more vigorously than ever before.

Whatever the outcome of oil prospecting might be, the outlook for producing some of Australasia's petroleum requirements from local resources is not discouraging.

Should all the combined efforts of private enterprise and Government support fail to find oil in commercial quantities, modern techniques could establish a nucleus of a synthetic fuel industry for times of emergency, based on the huge deposits of most suitable black and brown coals with which nature has so abundantly endowed the fifth continent.

Acknowledgment

The author wishes to express thanks to the Petroleum Information Bureau (Australia) Melbourne, for final checking of facts contained in the article.

[c]One well at Nerrima had reached a depth of 4271 ft.

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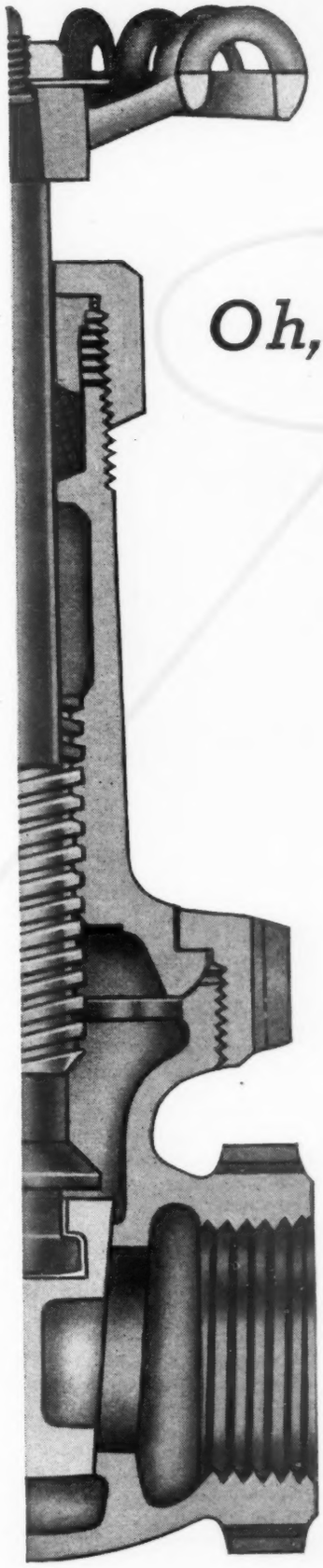

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What Do You Know?

Some gems in petroleum language add sparkle and jest even to the sesquipedalian world

RICHARD SNEDDON*

THE intimate record of the petroleum industry in all its ramifications is rich in odd and interesting items that should make excellent garnishment for technical discussions, and add a very distinct appeal to the platform orations and printed presentations of those organizations and individuals in the industry whose business it is to woo that fickle fellow, the man on the street.

We here present a miscellany of such items that may be common knowledge to the more erudite members of the industry, but being "off the beaten path" as it were, are not too well known to the majority of oil men. In any case, they constitute a small part of an accumulation of incidentals that the writer has used widely as literary condiment over the past 30 years more or less.

Every industry, every science, every sport, and every segment of society has its own quota of peculiar words and expressions that are only vaguely understood by those outside the pale, and to an astonishing extent are glibly used but little understood, fundamentally, by many on the inside. And yet, each word has a history, the tracing down of which is a sport as satisfying as a big game hunt, much less expensive, and certainly just as rewarding.

Let us consider, for example, some of the words we bandy about in the oil industry and see what we can learn about them. Americans, you know, are not only the greatest producers of goods and services in the world; they are also the most prolific compounders of new words and phrases, and the petroleum people are among the most lavish contributors to this program of language development. In the category of so-called portmanteau or telescopic words, such as "smog" and "brunch," the inventive oil field worker has recently come up with "flumper" for a well that is between the flowing and pumping stages. No doubt, as soon as other neologists get around to it, they will abbreviate the gas-lift well to "glifter"; one that is part of a water-flooding project may well become a "wafler"; and, who knows, a dry hole may even some day be known as a "drole."

Tackling the petrolic etymon with some degree of orderliness, however, we find a fertile field for study in the exploration department. Here dwell the sesquipedalians of the petroleum world, a sesquipedalian being one who is given to the use of words that are a foot and a half long (Latin *ped*, "a foot," and *sesqui*, implying "a half more") and the oil finding scientists are nothing if they are not polysyllabic. Among them are geologists, geophysicists, paleontologists, geochemists, geobiologists, and even such abstruse gentry as micropaleoichthyologists.

Ge is Greek, meaning "earth," and a "logist" is simply "one who is familiar with the science of," so a geologist is one who is unusually well informed on the earth processes; how the terrestrial surface laminations were laid down, and what eventually happened to them. The function of the geoscientist in the oil industry is to trace what Tennyson called:

"The sound of streams that swift or slow
Draw down Aeonian hills and sow
The dust of continents to be."

Physike is Greek for "nature," and the geophysicist, thus is also a researcher into the manner in which the earth's crust has been formed through the ages, and one of his most productive functions is to probe the subterranean deeps for the sort of formations in which old Mother Earth might be expected to secrete her precious petroleum hoards.

EXCLUSIVE

It is not unlikely that Moses was the first practitioner of this exciting profession. The Good Book tells us that at one time "he smote the earth with his rod and the earth shook and trembled." The present day geophysicist makes the earth shake, too; but he does it in a slightly different manner from Moses, actually by firing an accurately placed charge of explosive. Then he learns what he needs to know about the underground earth formations and malformations by studying the nature of the energy waves that bounce back off the various subsurface layers and structures. They vary quite markedly with the density and other physical qualities of the materials they encounter.

These so-called reflection waves are much like voice echoes with which we are all familiar, and the geophysicist has found a means of capturing them and recording them for more leisurely and more searching study. This involves the use of a series of geophones, strategically placed, to pick up the energy wave reflections, and a complex assembly that converts them into visible graphic form. The total device is known as a reflection seismograph, from the Greek *seismos*, an "earthquake," and is basically the same instrument as that used in our observatories to detect earth tremors, their point of origin, and their intensity.

The paleontologist derives his imposing moniker from the Greek *paleo*, meaning "ancient." He searches the subsurface for the skeletal remains of ancient marine organisms, and correlates depth with geologic time on that basis. It is commonly supposed, of course, that oil originates from marine organisms of some sort, hence the oil scientists' anxiety to locate old marine sedimentations of requisite geological age. It is hardly necessary, perhaps, to point out that the geo-chemist concerns himself with the

*Editor, Pacific Coast.

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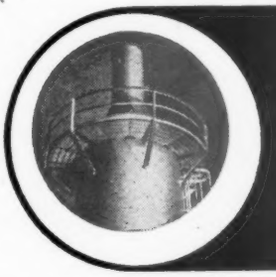

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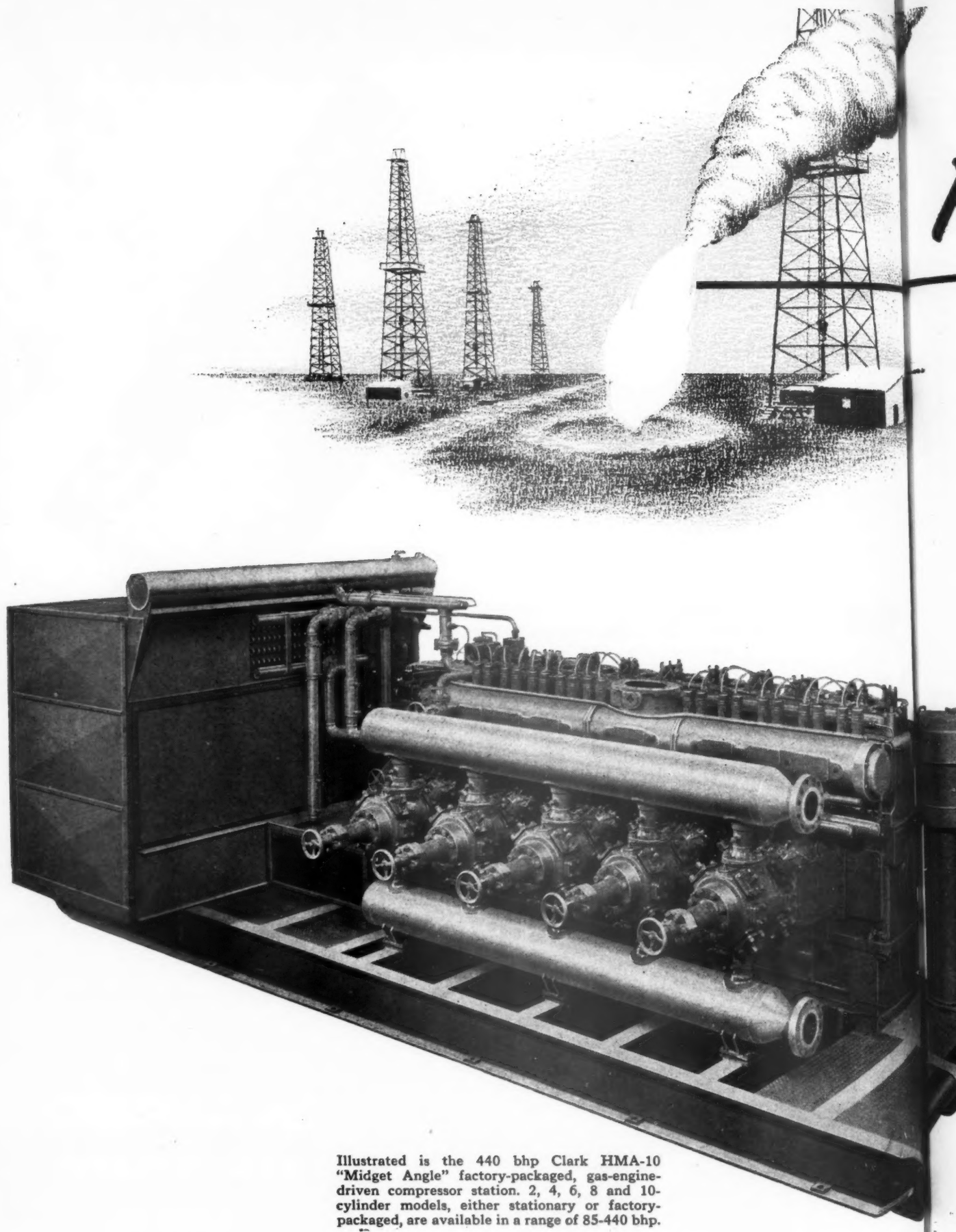

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earth's composition, and that the particular species of geochemist in which we are at the moment interested is mostly concerned with the occurrence of traces of hydrocarbon gases at or near the surface of the earth, and what he'd like to know is the relation between these phenomena and the occurrence of oil reservoirs somewhere down in the earth's bowels. The word "chemist" is of somewhat doubtful origin, but is believed to stem from the Arabic or the Greek and to have originally implied, "one who messes about with potions and infusions," or something of that sort.

The geobiologist scorns the dead past and does his best to fit all the pieces of the terrestrial jigsaw puzzle together by studying the types and behaviors of living organisms that exist in the earth's crust today. His name comes from the Greek *bios* which means "the phenomena of life," and if he is specifically interested in petroleum genesis and the location of oil deposits, he will be examining the haunts and habits of certain bacteria that have the faculty of forming petroleum, or at least producing its basic components, and then allowing chemical and physical forces to complete the synthetic process. It might be mentioned that bacteria can also destroy petroleum, and there is one species described as "thigmotactic" that can literally push the oil from one place to another in the subsurface by merely squeezing itself against the oil sand granules and displacing the fluid. These little fellows get their name from the Greek *thigmas*, meaning "touch," and *taxis*, indicating "an order" that has this peculiarity.

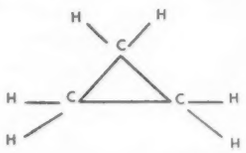
The geobotanist, or micropaleobotanist, to give him his full title, is a comparative newcomer to the select circle of the oil finding scientists. His title is derived from the Greek word *botanē* which which means "plant or herb," and he makes his subsurface correlations on the basis of spore and pollen fossils that he identifies under a powerful microscope. The presence and relative abundance of specific types of such fossils serve to identify the various depositions, and as spores and pollens were carried in all directions by the winds of their geologic eras, they can be used to map many underground strata in which no animal fossils are to be found.

"Ichthyology" is that branch of zoology dealing with fish, and the micropaleoichthyologist does pretty much the same thing as the geobotanist, using fossil fish remains, and especially fossil scales. It appears that fish scales have distinctive contours and conformations somewhat similar to those that make finger prints so valuable in crime detection, and so from a single fossil scale this geoscientist can tell what kind of fish it belonged to, what environment it lived in, and in what era.

There are other geoscientists studying the traces of certain rare minerals and earths that are peculiar to the vicinity of known oil pools, or may occur in these vicinities in greater (although still small) concentrations. These trace substances are determined by burning parts of core samples in an emission spectrograph, and examining the pattern of the light that is so emitted. Each substance yields a definitely recognizable spectrum or "image" when it is projected through the "spectrograph," a device that breaks up light into its component wave-length elements. Despite, the effort that is being concentrated on finding methods, it is still impossible to detect the presence of oil in underground reservoirs, so these scientists, each in his own way, continue to search for favorable environmental conditions and to compare or correlate their data in the hope of making the finding process more positive. It is significant that as of the present time, wells drilled in virgin territory without scientific aid are successful in one instance out of thirty, while with the best geological and geophysical help, the ratio is cut to one successful well in five.

What the scientists are looking for is petroleum; from the Latin *petra*, meaning "rock," and *oleum*, meaning "oil." It is not so termed because many people go on the rocks looking for it, but simply because the early seepages emanated from rocks and the two substances became associated in the minds of our early ancestors. Petroleum is largely made up of chemical compounds called hydrocarbons for the simple reason that they are composed of hydrogen and carbon. These hydrocarbons belong, in the main, to several well recognized families, principally the paraffins, naphthenes, aromatics, and olefines. The paraffins are known as "saturated" hydrocarbons because in them is the maximum quantity of hydrogen with which the carbon can combine. As they are satturated they have little tendency to combine with other chemical elements, and they are consequently remarkably stable. This will be easier to remember if it is coincidentally remembered that "paraffin" is made up of two Latin words, *parum*, meaning "little," and *affinis*, meaning "affinity." They have little affinity for other elements or compounds, so that those in gasoline, for example, do not tend to form gums, resins, and other objectionable compounds.

The napthenes are cyclic compounds, which simply means that their formulas fit into closed or ring designs, for example,



as compared with the straight chain formulas of the paraffins, like H-C-C-C-H. "Cycle" is derived from the Greek *kyklos*, meaning "circle," and the word naphthene is a descendant of *naphtha*, another Greek word that doesn't disclose too much of the etymology of our present usage as it merely means "moist." Perhaps it first applied to a sort of intermediate product between gas and liquid that was either a moist gas or a gassy moisture.

The aromatic hydrocarbons really do have a pleasing aroma to justify their name, which seems also to spring from a Greek root, one that had some relation to the pleasing scent of spices. The olefins, on the other hand, usually stink to high heaven and offend the olefactory organs no end—hence the name! They are rather unstable under certain conditions, but like the aromatics, have very good anti-knock quality.

Petroleum, as practically everyone knows, is made up of hydrocarbons, mainly in the several series already mentioned. They vary all the way from light gases through liquids to solids. Gases are normally described as aeroform fluids, which is not very satisfying, and the word "gas" itself is reputedly the invention of a Belgian chemist, Jean Baptiste von Helmont, which is also rather uninteresting. But, when it is suggested that Jean's word is merely a slurred version of the Greek *chaos*, used

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to convey the impression of incontrollability and abandon that the aeroform fluid conveyed to him, then the imagination begins to be mildly stimulated. "Liquids," of course, take their name from the Latin *liquidus*, "free flowing," and "solids" from *solidus*, "a substance that has its parts crowded together."

The value of petroleum or its products is related to a variety of physical qualities, such as API gravity, partly on the basis of which the price of crude oil is set. Actually, API gravity is something of an accident. In the early days of the petroleum industry, the gravity of crude oil was determined by Beaume hydrometer. This instrument was supposed to be so accurately calibrated and standardized that its readings bore a known mathematical relationship to the true specific gravity of the liquid being tested within very close limitations of error. When the American Society for Testing Materials, or perhaps the Bureau of Standards, made a careful survey of the hydrometers then in use, however, it was found that through some mistake in the manufacturing process they exceeded this limit of error, and actually conformed to a different mathematical formula. It would have been expensive and inconvenient to recall all the defective hydrometers and replace them, so in lieu of such a drastic step, they were allowed to remain in service under the name of API hydrometers, and the correct formula for conversion of readings to true specific gravity was also adopted. Thus, one must accept the Ripleyesque conclusion that the tremendously important API gravity system was in reality born of a blunder.

"Viscosity" is a commonly used word in the oil industry that has a most interesting etymology. It comes to us by way of the Latin word *viscum* which means "mistletoe." If a mistletoe berry be squeezed, it exudes an extremely sticky juice, and "viscosity" is thus "stickiness, or resistance to flow." "Mistletoe" is said to come from the Saxon *mysteltan*, which is composed of the Danish *mistel*, "birdlime," and *tan*, "a twig," which recalls the fact that some 50 years ago, boys in Scotland were wont to spread birdlime, made from mistletoe berries, on twigs, hoping thereby to trap some unwary sparrow. (As one of said boys, the writer must confess that he never caught any sparrows in this way, but there was a thrill to the adventure that made it exciting nonetheless.) It is interesting to note that mistletoe has another remote relation to oil in that it is the state flower of Oklahoma.

Now, looking into the drilling phase of the petroleum business, we find more vocables and operational oddities that are worthy of our attention. The "derrick" is believed to derive its name from a hangman at Tyburn prison in England whose name was Derrick. According to Joseph Shipley, a noted etymologist, it originally applied exclusively to a device for the hoisting of persons but later came to mean almost any kind of hoisting mechanism.

Speaking of derricks, it is difficult to believe that these sturdy structures could

"Come on fellows, I hear there's a new field called Spindletop."

be completely demolished by tiny birds, but that is true. In certain California oil fields, and perhaps in others, too, the timbers of the older wooden derricks, some of them well over 50 years of age, have been so completely stuffed with acorns by busy woodpeckers that the entire structures have collapsed from sheer lack of the necessary strength to stay up. The process of disintegration has been accelerated by wind and rain, mounting age, and the increasing ease with which woody woodpecker could perform his arboreal excavations. Perhaps future generations of these oil field scansorialists (from Latin *scansor*, "to climb") will evolve chrome vanadium steel beaks with diamond tips so that they will be able to park their acorns somewhere in the steel derricks.

Such bits of oil field jargon as "graveyard tour," "spudding in," "biscuit cutter," "the Kelly," etc., have been the subject of endless dissertation by experts, so for the moment, at least, we shall not attempt to elucidate on the general lingo of the business. The use of drilling mud, however, to perform a variety of functions has introduced some terms, one of which "quebracho," we should like to discuss briefly.

If you try to say the Spanish words *quiebra hacha* quickly, you will immediately understand the origin of the name "quebracho" which is applied to a well known mud thinner. *Quiebra* means "break," and *hacha* is from the same root as our word "hatchet." The quebracho is actually a tree from which is obtained a hard wood that has a tendency to break the lumberman's axe. It is found in the Latin American countries, particularly Argentina and Chile. The mud thinner is a crystalline substance extracted from quebracho fibers. A purified derivative is also used medicinally to relieve congestion in the bronchial tract so, in effect, it is used as a thinner there, too. Most of the quebrachos are rich in tannin, and their products are extensively employed in the leather industry.

The production of oil wells has varied down through the years from the lightest hydrocarbon gases to the heaviest asphaltic materials. From certain wells in certain areas, carbon dioxide is now separated, solidified, and sold as dry ice. Helium, an exceptionally light nonflammable gas, useful and safe in dirigibles and employed for many other purposes, is also extracted from oil well gases. Iodine is manufactured from oil well brines, and among other things, is extensively employed in metropolitan reservoirs to prevent goiter. Once some Pennsylvania operators even brought in a beer well. They drilled from the summit of a hill into the vaults of a nearby brewery and were much amazed to bail up a nice sparkling amber fluid that smelled strongly of hops. Being oil men, they didn't need any analyst to tell them that this was beer—one small sip did the trick.

There have been interesting developments occasioned by the discovery that the rotary bit in its early use had a tendency to meander far from the true perpendicular. Alexander Anderson, who was responsible for some of the industry's initial hole survey work, tells of attempts to gage the slant of the hole at any interval by lowering a bottle of sealing wax in a jacketed container to the requisite depth, and leaving it there long enough to cool and set. The tilt of the solid wax in the bottle indicated the angularity of the hole. The method was not too successful. Nor was the hydrofluoric acid bottle that came later, supposedly revealing deviation by the etching on the bottle.

Those methods, although crude in themselves, excited the perfection of accurate survey instruments for determining both angle and direction of deviation. Thus directional drilling was eventually transformed from an accident into an art. It brought into reach millions of barrels of oil that otherwise would have had to remain indefinitely in subterranean storage. Thus it was possible, in one instance, for a rich oil formation lying directly under a cemetery, to be produced without a word of dissent, by simply starting the hole some distance away, going down approximately 500 ft and then whipstocking underneath the cemetery. The whipstock tool, incidentally, takes its name from the buggy whip stock, which it somewhat resembles in shape.

In the pipe line department, it seems that the old line walker who really *walked* the line is rapidly being replaced by the air inspector. The latter zooms over the line in his small plane and has become very expert in the detection of leaks, breaks, or other irregularities. But most interesting of the new era line walkers are the buzzards and coyotes. Some of the sulfur compounds that occur in raw gas are violently objectionable to the human olefactory organs. They are atter-of-roses, however, to the sensitive schnozzolas of the two members of the animal kingdom mentioned, and gas line leaks are commonly revealed by hovering buzzards or howling coyotes which haunt the vicinity in the mistaken belief that the effluvium emanates from something dead—something that ought to be devoured.

Looking briefly into the refinery, in conclusion, we note that the two basic processes of this department are volatil-

ization and condensation. "Volatility" comes from the Latin *volare*, "to fly," and expresses the tendency to vaporize readily. When a petroleum liquid is heated, its hydrocarbons, one after another, turn into vapor in the order of their boiling points and "fly" from the liquid. They are caught in a cold tube or vessel and returned to the liquid state, or condensed, from the Latin *condensare*, "to make dense." Then in liquid form they trickle into a receiver. This whole process is termed distillation, from the Latin *stillere*, "to trickle."

The receiver can be removed at any time and a fresh one substituted, thus providing "cuts" or "fractions" having a definite range of boiling points which suit them to specific industrial needs. These cuts may then be treated to create desirable characteristics or to eliminate undesirable ones.

Usually from refining crude oil as it is produced, the first fraction to be removed is the natural gas which is separated partly at the well and is called "casinghead" gas, because it first asserts itself at the head of the casing. Next comes "gasoline," which is a sort of trick word formed by the combination of "gas," already explained; "ol," an abbreviation for "oil"; and "ine", a suffix meaning "of the nature of" or words to that effect. Following gasoline is the "kerosine" fraction, which derives its name from the Greek *keros*, meaning wax, probably because some of the earlier kerosines were distilled from waxy crudes. Then comes diesel oil taking its name from the diesel engine because it is the cut from which diesel fuel is made. Finally, there is nothing left in the still but *residuum*, which derives its name from the Latin *residere*, meaning in American "to stay put."

Lubricating oils are commonly made by steam distilling suitable crude oils, which merely means that steam is passed through the crude until it has carried off all the desirable lubricating oil fractions. The residuum in such an operation is often asphalt, and if you want to find out how blindly the lexicographers follow each other down through the ages, try to trace the origin of asphalt. *Aspahltos* was a naturally occurring bituminous material, but why it was so designated we have so far been unable to discover.

The few cuts or fractions mentioned, and many others less simply contrived, become base stocks for the endless processes of the modern refinery. These have designations quite as multisyllabic as the names and accoutrements of the geo-scientists. Among them is "polymerization" for the conversion of certain hydrocarbons to more desirable ones (usually in the gasoline range) of higher molecular weight. (It is from the Greek *polys*, meaning "many," and *meros*, "a part"). There are two types, "thermal," accomplished by heat, and "catalytic," functioning through the use of a catalyst, from the Greek *katalysis*, meaning "dissolution," and it should be noted that a catalyst to the chemist is a substance that accelerates chemical reaction without necessarily taking part in it.

Then there is hydrogenation normally employed to add hydrogen to relatively unstable polymerized stocks and make them into more stable products; dehydrogenation, which reduces the hydrogen content of other hydrocarbons to form more desirable constituents; alkylation, which develops compounds with higher alkyl content and a greater yield of high octane gasoline; isomerization, from *iso*, "the same" and *meros*, "part," a means of changing the arrangement of the elements in the molecule without changing its weight; and many others all presenting a golden opportunity for the amateur etymologist and the collector of curiosa really to enjoy himself.

These are, as already intimated, just a few random comments set down in the hope that they may stimulate others to search the industry archives more zealously and to track the elusive etymon more assiduously. Incidental knowledge of this type may not be effective in increasing the productivity of its possessor, but chasing it down certainly adds savor to a man's industry affiliation and excites a more intimate relationship between the man and his job. Besides, maybe Byron was right when he said:

"But words are things; and a small drop of ink,
Falling, like dew, upon a thought, produces
That which make thousands, perhaps millions, think."

* * *

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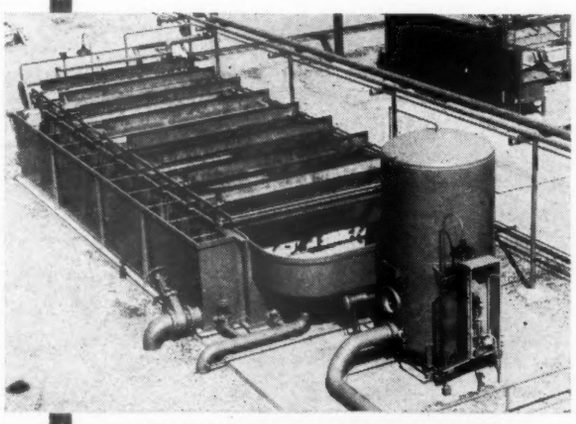
Oil-field brine "A"	40.0	5.0
Oil-field brine "B"	300 to 500	1.0 to 6.0



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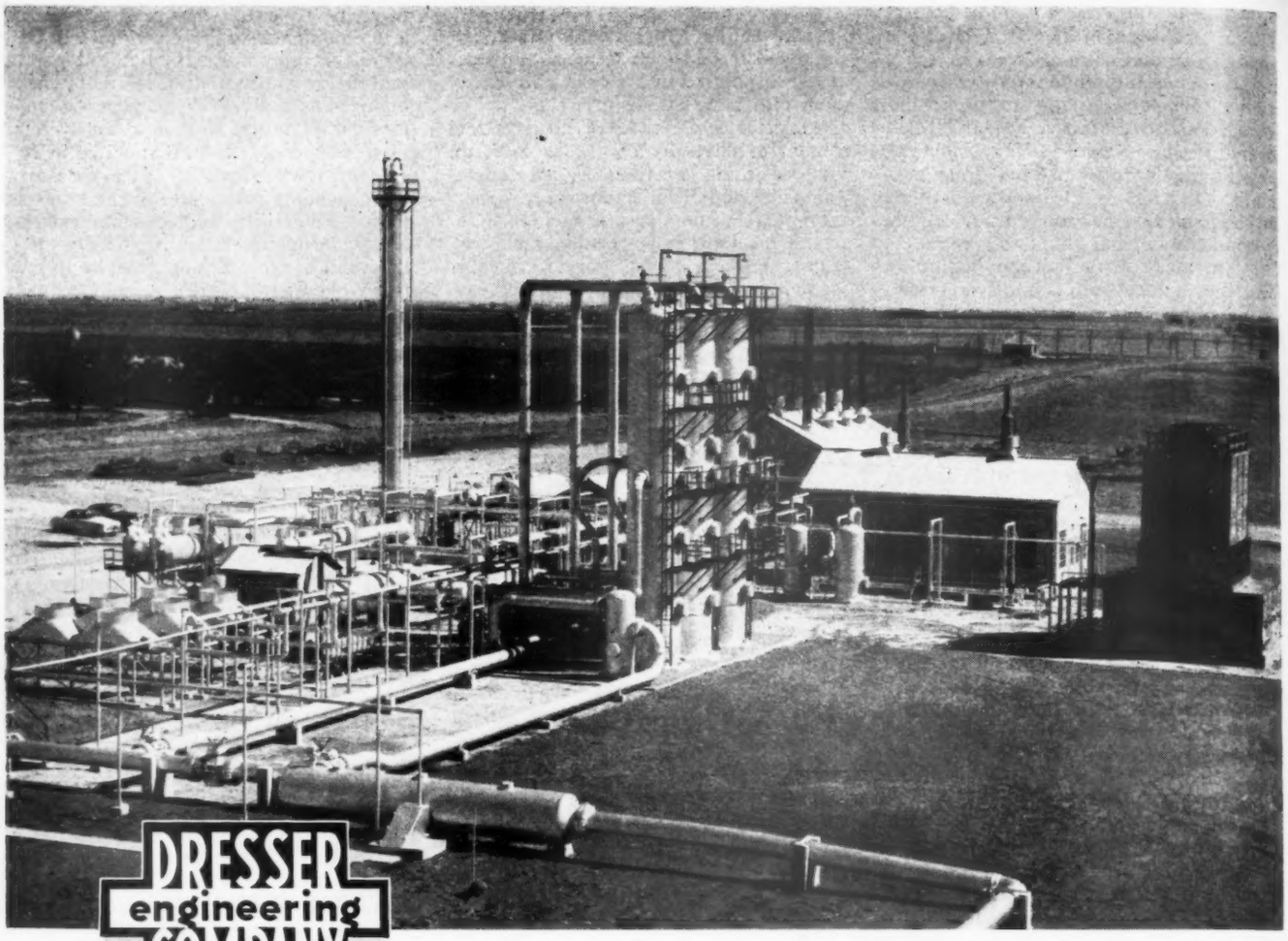

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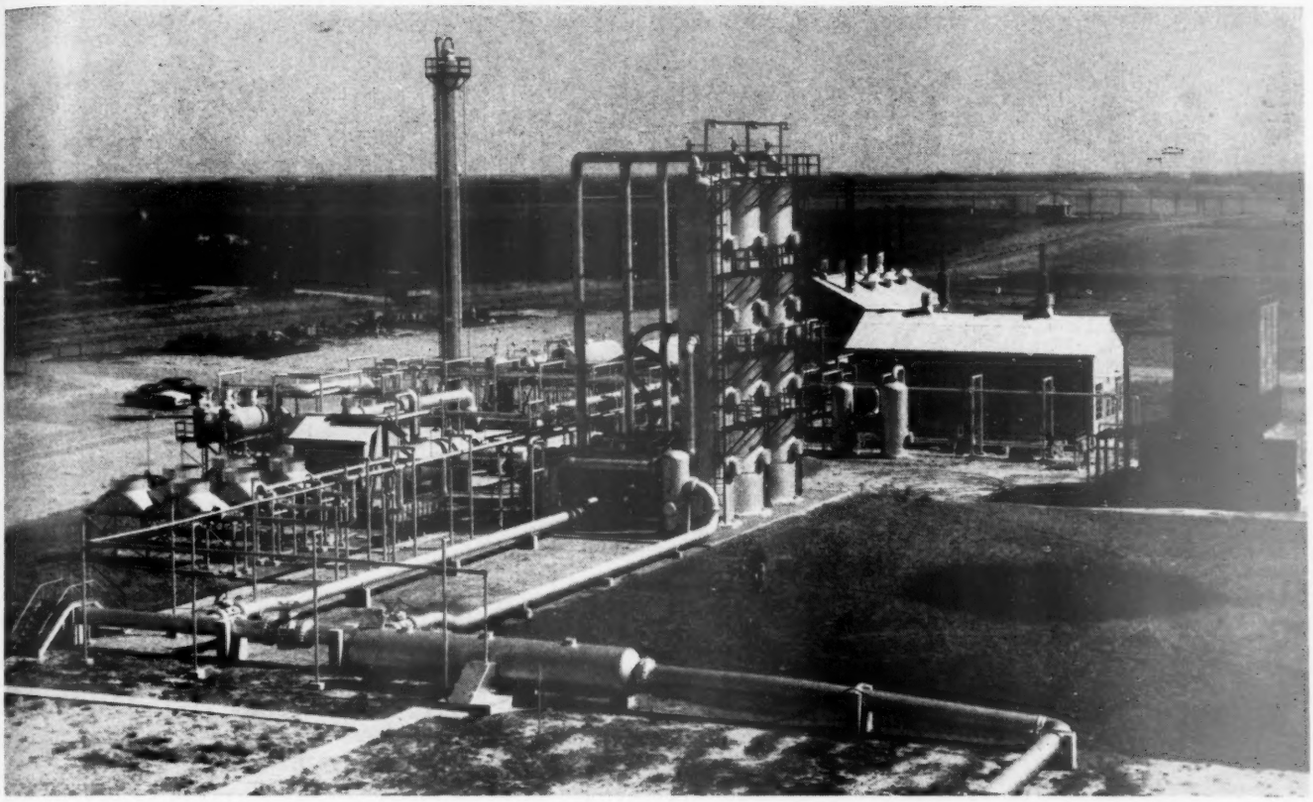


General view of Holcomb, Kansas, gas dehydration and refrigeration plant.

Extraction Plant Strips High Pressure Gas

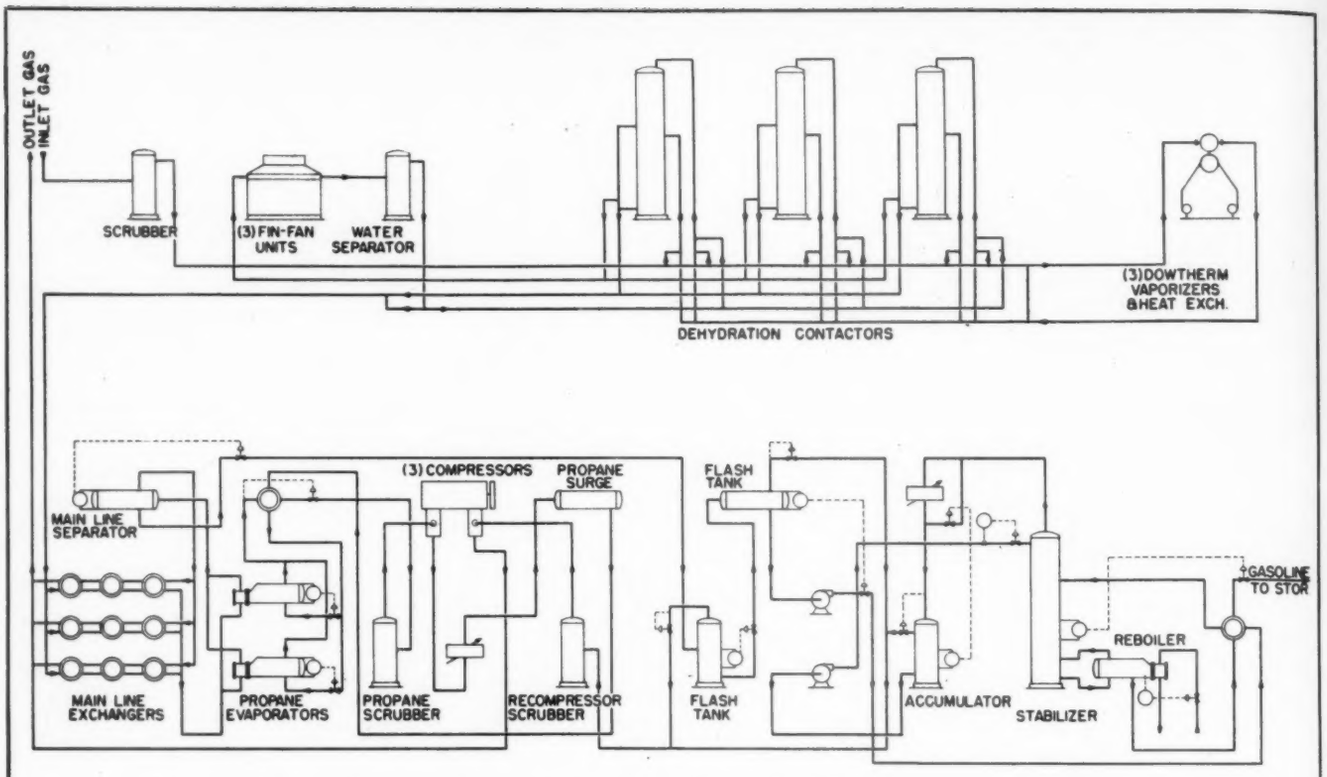
Northern Natural Gas Company processes 185 million cubic feet per day in new refrigeration plant, while maintaining heating value

CONTRARY to usually accepted processing practice for modern gasoline plants, Northern Natural Gas Company has a gas refrigeration plant at Holcomb, Kansas, designed, and operated to extract a minimum of natural gasoline from 185,000,000 cu ft per day of Hugoton field gas. This operation prevents hydrocarbon condensate difficulties common to transmission of high pressure gas without stripping, at the same time maintaining heating value of the gas at the maximum.

Although this gas contains approximately 15 per cent nitrogen and is inherently rather lean, it contains enough heavy hydrocarbons to cause a considerable accumulation of condensate in pipe lines particularly during winter months if it is not stripped. As this gas contains only .15 gal of pentanes and heavier per 1000 cu ft, the installation of a conventional absorption and distillation system, including 900 psig absorbers for 185,000,000 cu ft per day, is disproportionally expensive for the production of 27,000 gal per day of pentanes plus, which it would be possible to get. After careful consideration of the low quantity of pentanes and heavier and the need to retain as much heating value as possible in the main gas stream, it was decided that the prudent approach to the problem would be direct refrigeration of the gas to remove the heavy hydrocarbons. By this method the plant could be coordinated with prevailing transmission line operating temperatures and pressure, removing only enough gasoline to prevent condensate in the pipe lines. In the case of Northern Natural Gas Company, these pipe lines extend to the seasonally cold climate of Minnesota. Operating records over a number of years indicate that gas flowing temperatures of 30 to 34 deg could be expected on the northern portion of the transmission system. Prior to design of refrigeration plant tests were made by means of a pilot refrigeration plant, which confirmed the belief that an appreciable amount of hydrocarbon condensation would occur under the predicted temperatures and pressures in the transmission pipe line.

The gas refrigeration plant consists primarily of gas to gas heat exchangers, refrigerant evaporators, mainline separator, flash tanks and fractionator to handle the gasoline condensate. The gas enters the gas exchangers from the solid desiccant dehydration plant at 850 psig and 90 F, and is cooled to 32 F in nine 30-in. diameter exchangers arranged in three parallel banks. At this temperature the gas enters two 46-in. diameter propane evaporators, operating in parallel, where it is further reduced in temperature to 20 F, and emerges approximately 98 per cent gas and 2 per cent liquid.

This mixture then enters a 6 ft ID by 20 ft horizontal separator where the liquid drops out for further processing. The stripped gas then re-enters the gas



NORTHERN NATURAL GAS COMPANY HOLCOMB GAS DEHYDRATION AND REFRIGERATION PLANT.

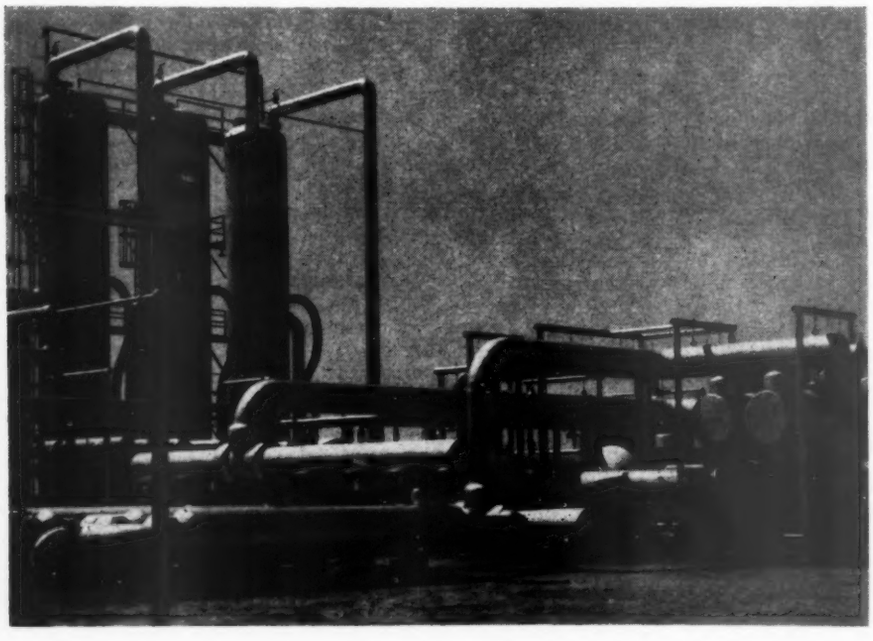
exchangers and is heated from 20 F to 76 F by cooling the incoming gas. The total pressure drop through the refrigeration plant process is 8 psig.

Liquid hydrocarbons dropped out in the main line separator at 20 F and 850 psig are first flashed at 400 psig then at 200 psig both without any additional heat required. The remaining liquid is pumped at approximately 0 F through heat exchangers to the fractionating column, which is essentially a depropanizer, the kettle temperature being controlled to produce the desired grade of finished product.

The vapors from the two flash tanks and from the fractionator reflux accumulator are valuable from the standpoint of having a high Btu value. These vapors are recompressed from 200 psig to 850 psig and reinjected into the main gas pipe line leaving the plant.

This type of plant will produce approximately 20,000 gal per day of 26-lb gasoline as a by-product while removing troublesome pipe line condensate. The operating temperature of the refrigerant evaporators is adjusted to produce a hydrocarbon dew point in the stripped gas just below the seasonal gas flowing temperatures in the northern sections of the transmission pipe line. The hydrocarbon dew points may, therefore, vary from 25 F in cold weather to as much as 40 F in the summer months. The heating value of the gas is thereby maintained at its maximum value, and there is no loss of pipe line efficiency from hydrocarbon condensate. Compressor station maintenance costs arising from gasoline contamination are also eliminated.

Dehydration contactors, left, vaporizers, and heater exchanges.



The refrigeration and vapor recompression duty of this plant is handled by two 330-hp vertical compressor engines, each having two compressor cylinders on refrigeration propane vapors and one compressor cylinder on vapor recompression service. Total horsepower required to compress the propane refrigerant single stage from 32 psig to 170 psig is 538 hp. Seventy horsepower is required to compress the propane and lighter vapors from 190 psig to 850 psig.

A single cell induced draft cooling tower is used to condense refrigeration propane and fractionator reflux in atmospheric sections. Air fin cooling units are used to cool engine jacket water and engine lubricating oil. One complete cooling unit powered by a 7.5-hp electric motor is used for each engine. The only hydrocarbon pumps used are one each for fractionator feed and reflux with a common stand-by provided for both services.

As a large volume of this gas is dis-

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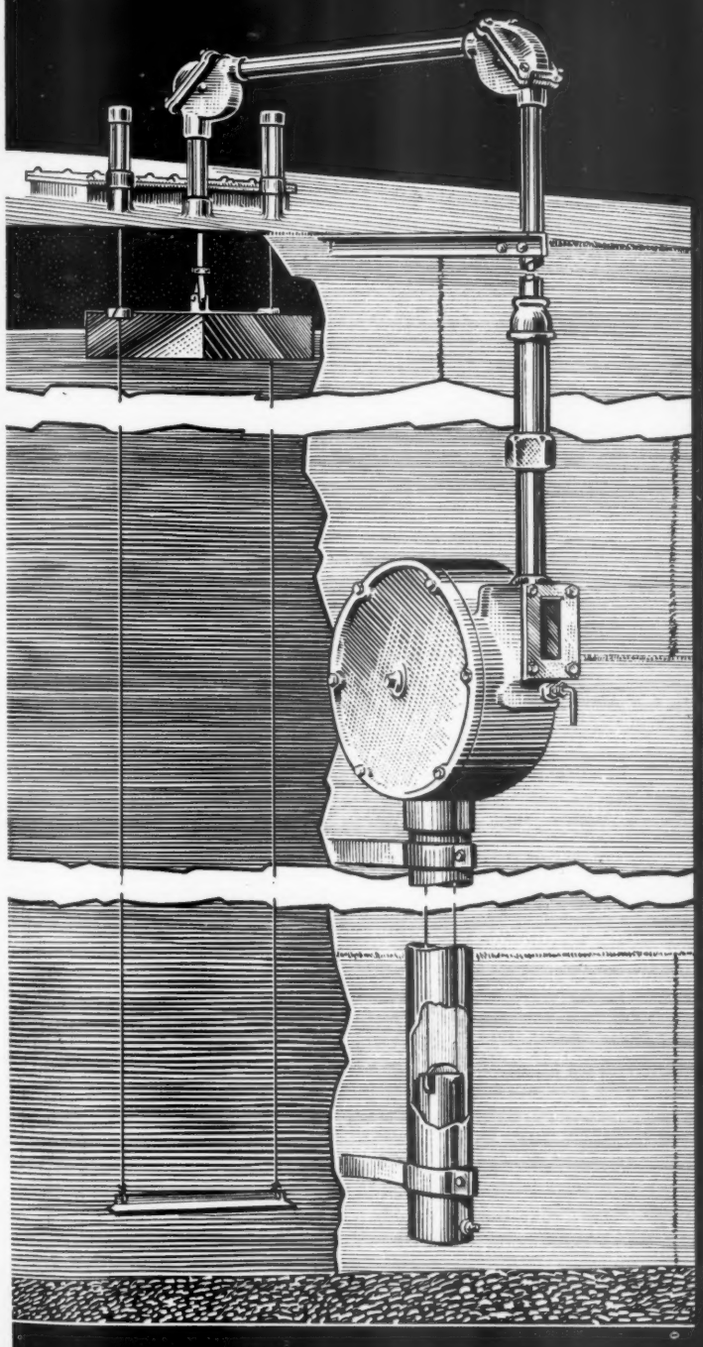

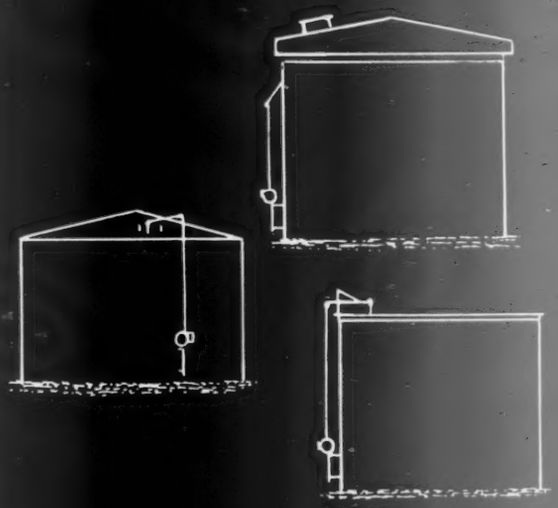

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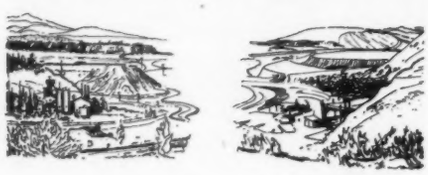

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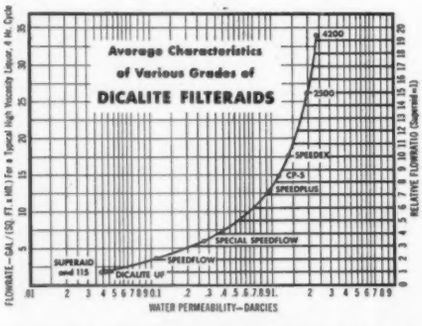

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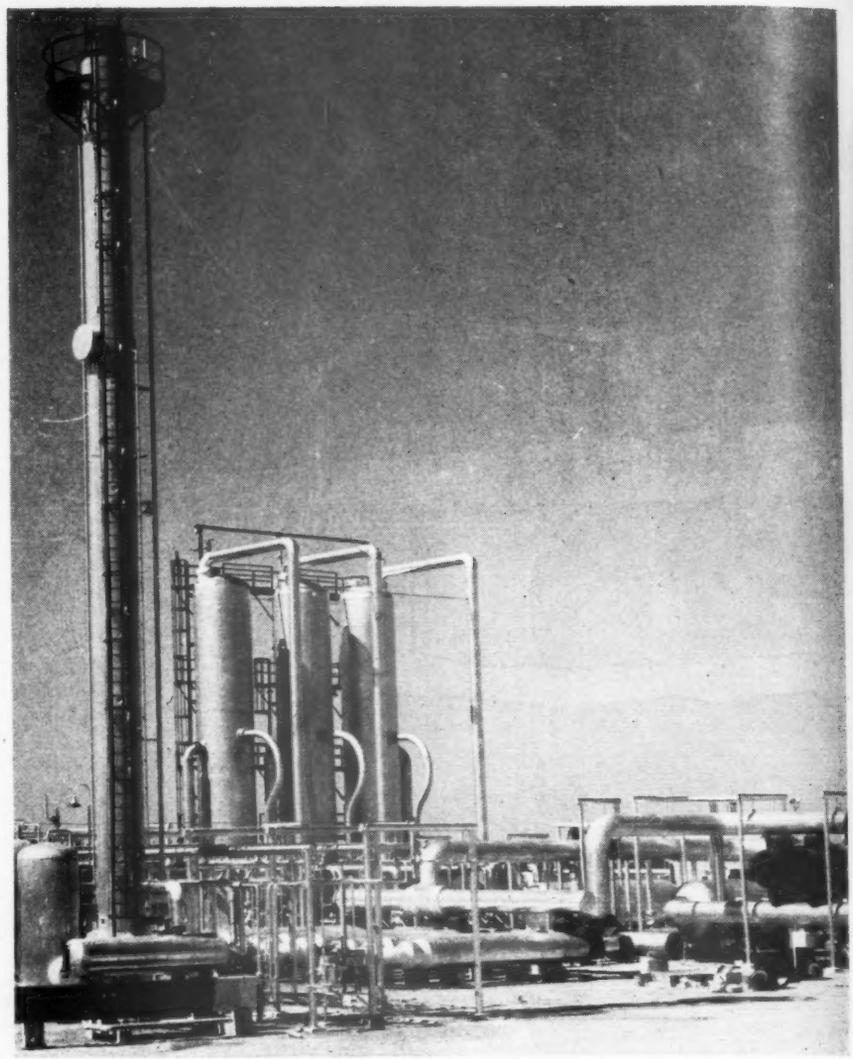

Fractionator, dehydrators, and heat exchangers.

tributed in the cold climate area, it is deemed necessary to dehydrate the gas to a dewpoint of 0 F, or lower at all times. Dehydration is accomplished prior to the gas entering the refrigeration plant, in a solid desiccant dehydration plant.

Three 7-ft 6-in. ID by 42 ft adsorbers are used, each adsorber containing four solid desiccant beds each 8 ft in depth. The vessel is divided into two halves by a diaphragm at the center with the top half and bottom half operating in parallel. The plant is operated with two adsorbers on active stream, one off-stream for reactivation. The time required for the reactivation cycle is eight hours.

The reactivation gas is heated with Dowtherm vapor by means of heat exchangers mounted directly above the Dowtherm vaporizers. In this manner the reactivation gas is heated to 400 F by means of 500 F Dowtherm vapor at pressures of 20 to 30 psig. The Dowtherm vaporizers, similar to water tube boilers, operate fully automatically, as the furnace firing controls are set to maintain 500 F at the vapor drum.

The adsorbers are reactivated at main line working pressure by taking a small percentage of the inlet gas through the Dowtherm heat exchangers, thence through the adsorber being reactivated. From the adsorber the reactivating gas stream passes through air fin coolers to a separator to remove the liquid condensate, then co-mingles with the main gas stream as it enters the adsorbers on stream. The pressure drop through the dehydration plant is approximately 3.5 psig.

In order to minimize the heating and cooling loads, the adsorbers are insulated internally with 2-in. insulating material. A 16-gage steel liner is then placed against the 2-in. insulating material to support and protect it from deterioration. By installing the insulation on the inside of the vessel walls which are 2.65-in. thick, the heating and cooling of this steel is avoided, and thereby the reactivation gas volume is reduced to about 70 per cent of that required if the insulation were to be applied to the exterior.

The gas dehydration and refrigeration plant was designed and constructed by the Dresser Engineering Company of Tulsa, Oklahoma, from data developed by A. L. Vaughan, superintendent of compressor station, Northern Natural Gas Company, and the co-writers. ★ ★

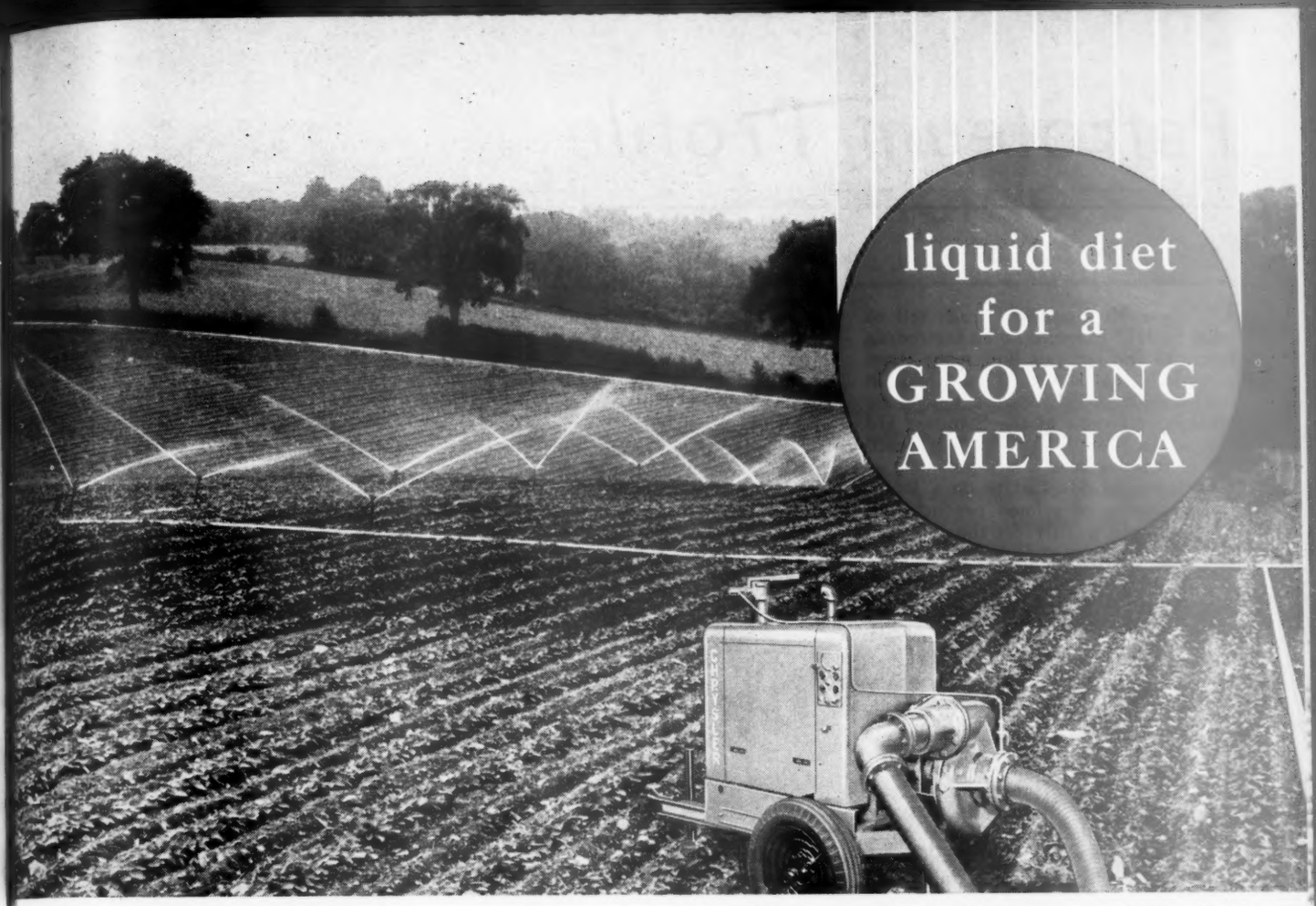

Photo courtesy Marlow Pumps, Ridgewood, New Jersey

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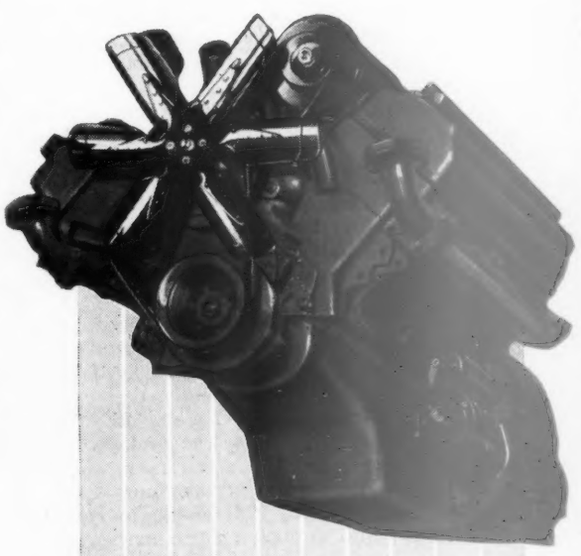


CHRYSLER

Industrial Engines

HORSEPOWER WITH A PEDIGREE

Petroleum Profile

E. B. McCONNELL

Vice President

Standard Oil of Ohio

"LET'S see Mc.—maybe he can tell us what to do!" It would be an interesting figure to find out just how many times essentially that statement was made in the period from 1920 onward, among the cracking divisions of the Standard Oil companies. For Elliott B. McConnell has not always been a vice president of manufacturing. He had to do a lot of manufacturing of refined products before he could qualify for the job with Standard of Ohio, wherein hundreds of men may refer to him as The Old Man.

Neither scientists nor psychologists are at all certain as to just how much effect prenatal influences have on the personality and predilections of individual human beings. But if this influence is a strong one, it early marked E. B. for its own. He was born in Oil City, Pennsylvania, cradle of the oil refining industry, and one of the outstanding birthplaces for oil men. Of him it might be said, as it is said about many oil men, that the milk in his childhood's glass must have a petroleum flavor to be palatable.

Hieing himself to Cornell University in 1919, he was "released" in 1923 with the bachelor in chemistry degree, to go immediately to Standard Oil Company of New Jersey. The "Turbulent Twenties" in oildom was the period especially of rapid developments in oil cracking, to augment our motor fuel supply. Cross, Dubbs, Holmes and Manley, Jenkins—the pages of oil refining history of that period are dotted with these and hundreds of other names famous in the art of cracking. And it was not always merely oil that was "cracked"; the term was applied to the men pushing the work. Certainly steel went to pieces as men learned "the hard way" to decompose heavy into light hydrocarbons.

McConnell took a six month's training course to supplement the more fundamental knowledge gained in Cornell; went as neophyte into the cracking coil service-and-development division of "Jersey," and served as a troubleshooter. Very shortly he was made process inspector of "Tube and Tank" cracking units, the first successful process to go to really high pressures. A fiend for punishment, his education began to progress by leaps and bounds, as he visited 15 refineries twice annually, listened to and studied their legions of troubles, and sought to solve the problems. He became finally the clearinghouse for cracking technology and new developments, and in 1927 went to Standard of Ohio to start up two new cracking coils in the Cleveland refinery, in the Valley of the "Kinky Cuyahoga" (River).

The manufacturing vice president of Sohio needed an able assistant so McConnell got the job in 1928, and until 1945 rassled with the multifarious problems that beset a refining chief. In that latter year he moved up to general manager of the manufacturing department, a way-station en route to the vice presidency mantle which fell on him on the retirement of his chief and mentor, George Hanneken, in 1946.

As is the case with all leaders in the industry, much of his time is occupied with extracurricular duties. Expectably McConnell is a member of the American Chemical Society, peer of all organizations of its type, American Petroleum Institute, for which he is member of its General Committee and its Refining Division's Advisory Committee, and member of American Management Association. These memberships are and would be fundamental to his position. But in the forum of public affairs he shines equally brightly. To Cleveland's Bureau of Governmental Research he is trustee. In his remaining "idle (sic)" moments he works with Cleveland Council on World Aflairs, the Ohio Forestry Association, and is an Elder Statesman on the Advisory Board of the local St. Alexis Hospital. Intertimes he serves on one of the numerous indispensable military-civilian groups, the Military Fuels General Advisory Committee of the Petroleum Administration for Defense.

During the Second World War he served with the Technical Advisory Committee of Petroleum War Council as consultant on aviation fuels to the PAW advisory committee, spent nearly half of 1942 as special assistant to the Refining Division's director, and with the Petroleum Administration for War, during nightmarish days when we were getting to the battlefront with "Too little, too late." And it largely is to the eternal credit of that hard-driving body that the expression became obsolete.

And McConnell has found time to aid in raising three boys, a full time job in any family. On occasion he may be found at the Country Club, or within the austere walls of Cleveland's old-and-venerable Union Club, member of both.

One English adjective has never been applied, except possibly in jest, to McConnell: Noisy. Always quiet, with "mind open and mouth closed," as a friend puts it, a little poker-faced on occasion, he is automatically at home in any atmosphere in which he is.

Report to the Stockholders

Everybody in the oil industry should be aware that he has an important job. Moreover, it is important that the industry be strong, progressive, and free. Everybody in the nation has a share in the affairs of the country. Because the oil industry is a vital part of the nation's economy, everybody should strive to insure that oil progress is not stifled by governmental control.

Congressman Lloyd M. Bentsen, Jr., ably discussed the matter at the API meeting, Fort Worth, Texas, in March, 1953. Extracts from his speech, "Report to the Stockholders," follow.

"Every individual citizen in a free land owes a responsibility to his government, just as the government owes certain responsibilities to him. The same is true of business. The larger the business, the greater the responsibility. Each of you here, no doubt, regards yourself as primarily a business man in the petroleum industry. You own stock or an interest in your concern. But never forget that as long as this is a free country you are also stockholders in another corporation — a business bigger than the oil industry — a business in which you can hold only one share of stock — stock in this nation of ours. There are 150 million other stockholders, so you may be inclined to underestimate the value of the one share of stock you hold. That would be the most dangerous thing you could do. If you do not actively participate in the affairs of your government — others will, and your goals may thereby be lost.

"Since you do own stock both in the petroleum industry and in your government, you cannot afford to neglect one at the expense of the other. If you do not tend to the affairs of government in order to keep our nation strong and prosperous, your stock in the petroleum industry will depreciate and may become valueless.

"When a big business gets into the red, no longer makes a profit, has too many useless employees, performs a great many services which the stockholders do not want, they overturn the business, get a new chairman of the board, fire the old board of directors and hire a new one.

"That is just what you have done this November fourth. Whether or not that is enough remains to be seen. I rather doubt that it is. All men are mere mortals and there is no world-shaking difference between Republicans and Democrats. The new manager — the new board of directors — cannot perform miracles.

"However, if all 150 million of you concern yourselves more directly with the operation of this corporation, it will once again get on its feet and perform useful and necessary services for you.

"Our present fortunate condition does not come about automatically. It has come about because the oil was there to be found and because the oil industry had the imagination and economic strength, plus the incentive to overcome the difficulties it had to face in getting it. The very wise law which permits the depletion allowance has been a magnificent stimulant to further explorations. Our reserves are now being strengthened by the greatest drilling activity in the history of our oil industry, both in terms of numbers of wells and the increasing depth of the wells.

"Those who regard the depletion allowance as a tax loophole must be reminded again and again of (1) our necessity for building up reserves for peace and defense; (2) the pyramiding use of oil and gas; (3) that easy-to-find oil deposits have been already discovered, that most wells today are deeper and more expensive, that the gamble is even greater; (4) the incentive to encourage drilling is even more necessary today for our nation's security.

"Consumption of oil and petroleum in the United States amounts to two-thirds of the free world's total annual petroleum production while our own proved domestic reserves amount to only one-third of the free world's total. Since it is believed that our total consumption of petroleum will be twice as great 25 years from now as today we must aggressively push exploration.

"Edmund Burke once said, 'All that is necessary for the triumph of evil is that good men do nothing.' "

How is the
"Working Surface"

No shallow teeth to fill up.
Blade Blocks are securely held safe from loss in the hole.
Deep-set hard facing on sharp, long-lasting shearing edges.
Proper direction and angle of shear on cutting edges insure positive shearing with no danger of "screwing down" past burrs.
Springs hold scraping edges in positive contact with wall of casing.
Six Blade Blocks provide 360-degree contact, and stabilize for smooth rotation.

Baker Model "C"
ROTO-VERT Casing Scraper
Product No. 620-C

Unless the inside of your casing—the vital "working surface"—is clean and smooth, there is always a possibility of trouble in future operations. Burrs from gun-shot perforations, hardened cement or mud, and even mill scale are all dangerous when the time comes to run testers or swabs, or to set cement retainers or packers of any description.

The Baker Model "C" ROTO-VERT Casing Scraper removes all obstructions from the inside of the casing, leaving it clean and smooth. Burrs or imbedded bullets are sheared away; cement, mud and scale are scraped away, so that any down-hole work can be safely done at once, or during the years to come.

SCRAPE WHILE DRILLING OUT

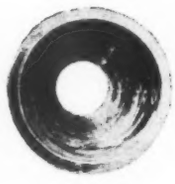
The ideal time to use the ROTO-VERT Casing Scraper is during the drilling out of cement, at which time it is run as a "follow-up" behind the bit. Thus in a single run you can also remove all hardened cement, mud, burrs and scale which might *later* damage swabs or testers, and cause packers or retainers to set prematurely—or never set at all.

EASY TO RUN—LOW-COST RENTAL

The Baker ROTO-VERT Casing Scraper is simple to run, and will effectively clean the inside of the casing when either reciprocated or rotated.

No service man is required, and the low rental cost is paid for many times over by freedom from future damage to bailers, swab rubbers and packers, as well as by the elimination of future delays and re-running expense.

SEE HOW THIS BURR... ripped this packing element,



and how ROTO-VERT could have prevented the damage by shearing away the burr.

# of your casing?

WHY **THE ROTO-VERT IS SAFE AND SIMPLE TO USE AND COSTS LITTLE TO RUN**

This helix-blade-type scraper can be either "spudded" (reciprocated vertically) or rotated for the removal of gun-perforation burrs, imbedded bullets, cement sheath or other obstructions from the inside of the casing.

The body is machined from bar stock, with two sets—a total of six—rugged Blade Blocks positioned for overlapping, 360-degree scraping coverage. The most outstanding feature of the Blade Blocks is the direction and angle of shear of the scraping edges. The slant of these scraping surfaces is in a direction OPPOSITE from that encountered on other helix-blade-type casing scrapers, and the shearing edge is set at a smaller angle from the horizontal. These features result in the fact that the ROTO-VERT will not "screw" down past burrs as it is being rotated. And when it comes to removing cement sheath or other casing coatings, you are assured of actually removing the material with the ROTO-VERT, instead of merely cutting threads in it.

REMOVING PERFORATION BURRS AND BULLETS

On rotary rigs best results are obtained by first running the ROTO-VERT Scraper *completely through* the perforated section WITHOUT ROTATION. This initial run will either shear or knock off the majority of imbedded or projecting bullets, and shear away most of the ragged perforation burrs. Then pull back the ROTO-VERT Scraper and rotate it through the perforated section. This second run permits the helix scraping edges to shear to their fullest extent, leaving perforation holes practically flush with the casing I.D., and the entire perforated section clean and restored to gauge.

When running the ROTO-VERT on tubing, or on a wire line (with suitable sinker bars and jars) it is merely run through the perforated section, then pulled back and run through again. If the ROTO-VERT runs through the perforated section smoothly (as indicated by checking the weight indicator) complete burr and bullet removal is a certainty.

REMOVING CEMENT SHEATH, HARDENED MUD OR SCALE

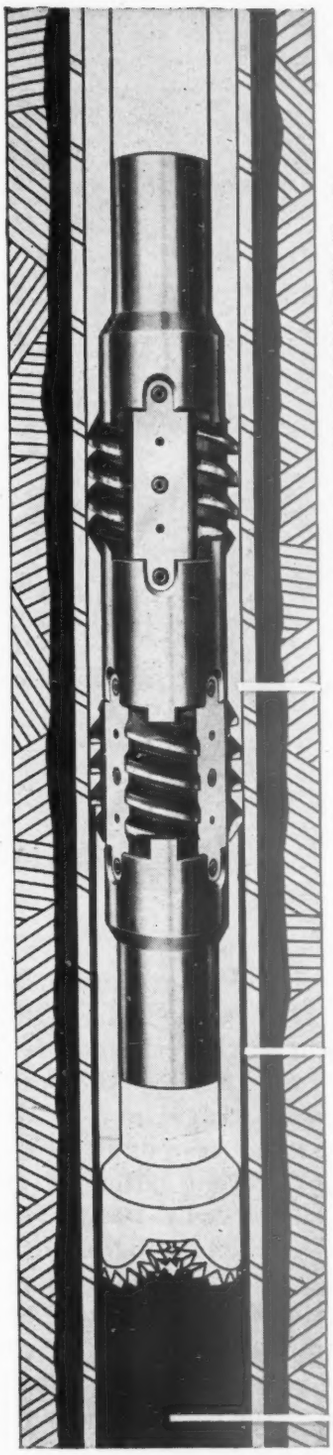
Recommended procedure is to install the ROTO-VERT just above the bit when drilling out cement, to remove the thin sheath of cement always left, even though a maximum gauge bit is being used. Hardened mud, cement, paraffin, or mill scale are completely removed in a single run.

On old wells (or when rotary equipment is not present) the ROTO-VERT, run on tubing, will successfully remove various casing coatings WITHOUT ROTATION. A spudding action usually quickly clears up any rough or stubborn "tight spots."

A modified ROTO-VERT can be furnished to operate with equal success when run on a wire line equipped with sinker bars and jars.

BAKER OIL TOOLS, INC.

HOUSTON • LOS ANGELES • NEW YORK

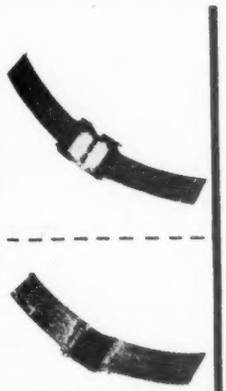


Even when a maximum gauge bit is used for drilling-out, a thin sheath of hardened cement remains to interfere with future operations. To visualize how ROTO-VERT removes this sheath, see left.

All cement, scale, burrs, etc., have been removed by the ROTO-VERT Scraper, and the vital "working surface" of casing is left clean and smooth.

This thin sheath of hardened cement always remains after the bit has passed.

Cement to be drilled out.



Cross-section of casing showing gun-perforation burr, before scraping...

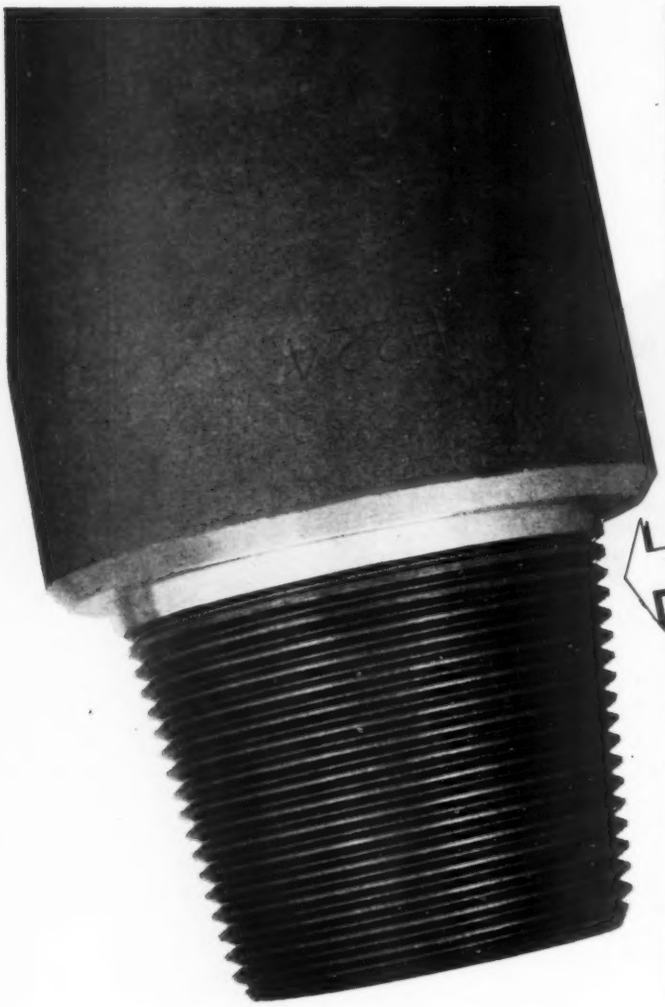
and after ROTO-VERT was run.

This brittle cement sheath prevents the slips of pack-off tools from gripping the casing.

...Here is cut section of the same casing showing how slips tried, *unsuccessfully*, to set against the cement sheath.

Call Baker

for consultation and service on BAKER ROTO-VERT Casing Scrapers



Another important reason why

REED TOOL JOINTS

last longer!

An important cause of tool joint replacement is the galling of threads during the vital breaking-in period. To help minimize this trouble, most operators handle tool joints with extra care when new.

Even the best of care is not enough, however, to prevent galling of untreated tool joints. That is why **REED** Tool Joints are given a treatment that changes the surface of the steel into a complex metal phosphate. This surface acts like a lubricant that won't squeeze out. It effectively prevents galling during the breaking-in period.

It is one of the many important reasons why **REED** Tool Joints last longer.

The phosphate treatment that gives REED Tool Joints their dark, dull surface also helps prevent galling during the breaking-in period.

REED ROLLER BIT COMPANY

HOUSTON 1, TEXAS

NEW YORK LONDON BUENOS AIRES

4124

To obtain more information on products advertised see page E-59

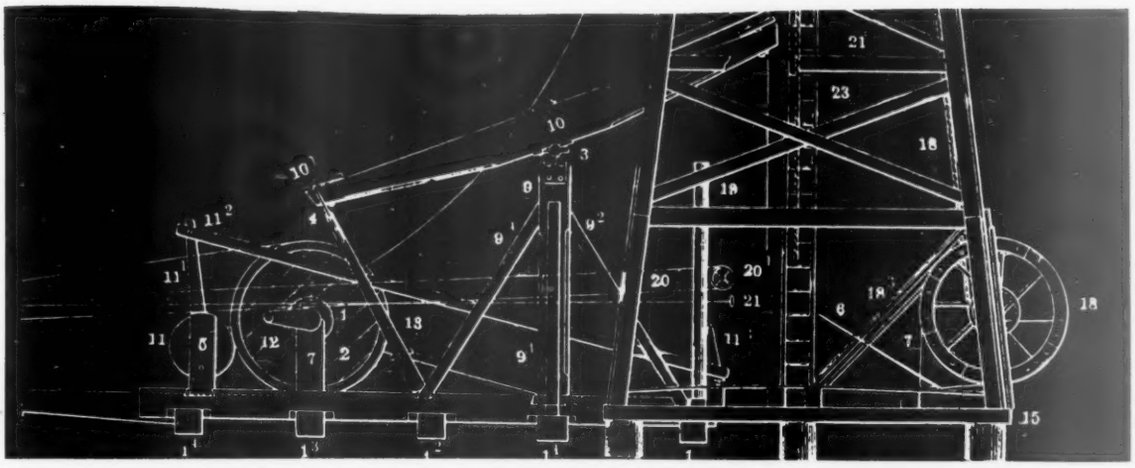


FIG. 1. In the old days the standard ends were retained for pulling and pumping the well.

How to Have Better Workover Operations

The lifting cost factor is an important consideration and the expenditures on well maintenance must be within economic limits

JESSE L. MOORE

In this article it is endeavored to show the importance of consideration and cooperation between the workover contractors and the oil operators. The workover contractors, with their technical know-how, and the oil operators, with their procedures and techniques, must work together if a profit for both is to be gained from remedial work on oil and gas wells.

In the early days of oil production very little thought, if any, was placed upon the future necessity of re-working wells in order to maintain production. As many of the wells in the beginning were shallow, offset wells were usually drilled to replace those that ceased to produce. As drilling equipment, however, was continuously being improved and wells were being drilled deeper it became evident that pulling equipment would be needed for re-working of wells if maximum revenues were to be obtained from their completions. Until the late 1920's standard drilling equipment was most widely used for pulling wells. Upon completion of a well the drilling tools were removed and the standard ends retained (Fig. 1) for pulling and pumping the well when such was needed. In the case where only rotary rigs were used the standard ends were later installed when needed.

The Author

Jesse L. Moore organized Moore Petroleum Service, an oil well servicing company, in 1945. He studied petroleum engineering at Texas A & M, later volunteering for the Armed Services where he spent four years as a navigation instructor in the Air Corps. He attended San Marcus Teachers College one year, but realizing he was not interested in the work he was studying left school to join Gulf Oil Corporation as a roustabout and roughneck. After two years of this work he resigned from Gulf to study petroleum engineering at Texas A & M so he could go further in the work he had chosen to make his career.

The steel derrick, which had its beginning about 1908 with the development of the tubular derrick, had practically replaced the wooden derrick by 1925. Operators would buy heavy steel derricks for the drilling of wells and replace them upon completion with light steel derricks for remedial work. These light derricks were successful where light work was to be performed, such as pulling and running tubing and rods, washing sand from the well bore, etc. When it became necessary, however, to handle heavy strings of drill pipe for milling windows in casing, side tracking, drilling deeper, or pulling screens and liners these derricks were found to be too light. It was then necessary to dismantle them and erect standard drilling derricks and move in drilling equipment. The additional cost necessitated by using this procedure plus the fact that wells were being drilled deeper resulted in most cases that the light derricks were not being erected for remedial work.

In 1938, shortly before World War II, a new era opened to the oil industry with improvements in power equipment and the development of the jack-knife derrick. As these derricks were built for light, medium, and heavy work the idea of not erecting permanent light derricks for remedial work became ever more popular with the oil operators. In many cases a light weight work-over unit is required and the portable gin-pole rig

EXCLUSIVE

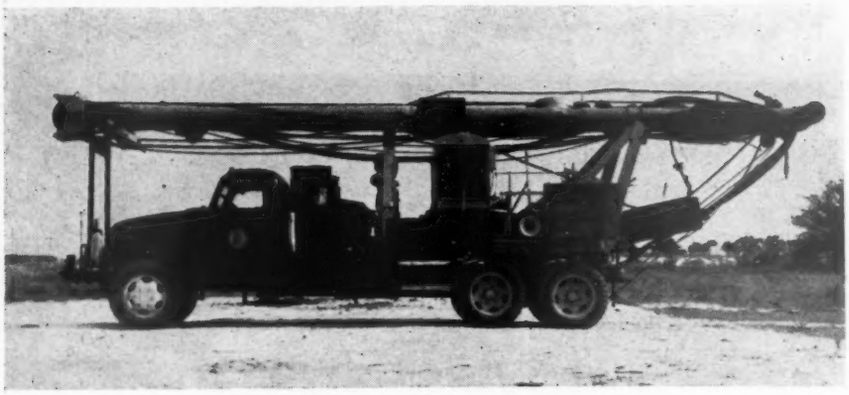


FIG. 2. A portable gin-pole rig has proved successful in workover operations.

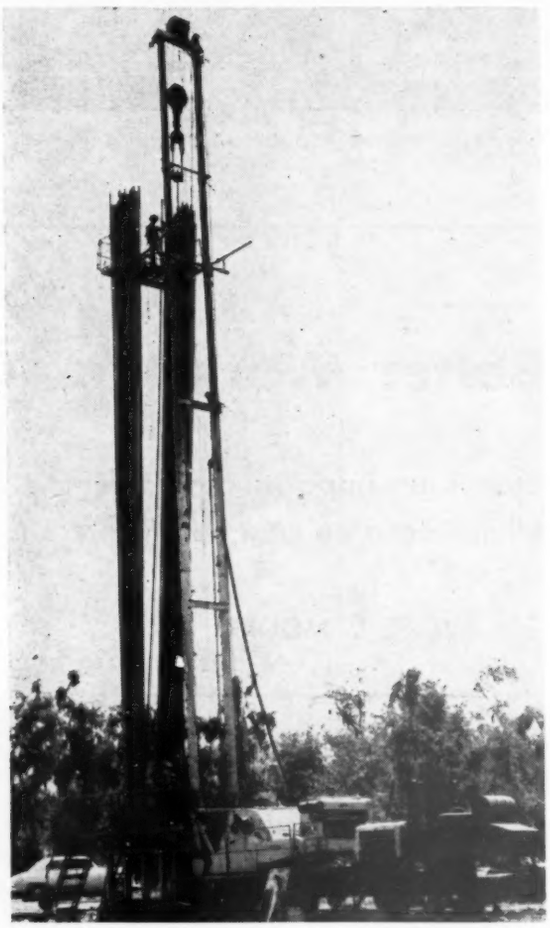
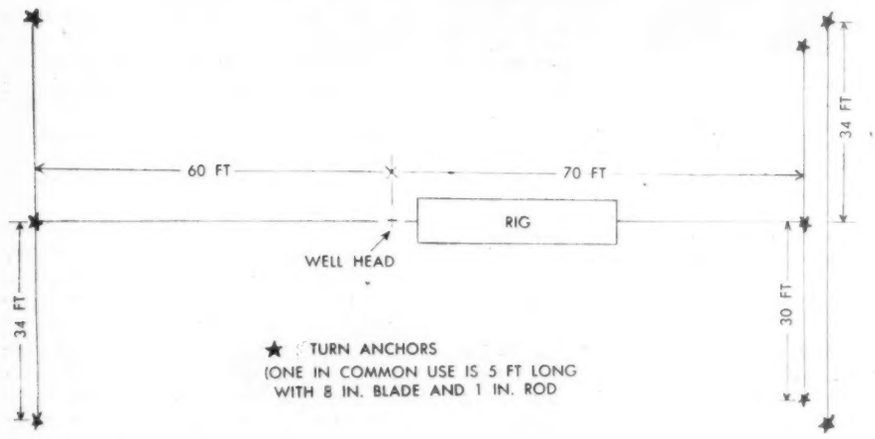


FIG. 3. A trailer mounted tubing hoist is a useful pulling unit.

FIG. 4. An ideal anchor setting that is applicable to all types of rigs.



(Fig. 2) for such operations has proved beneficial to the oil operator.

For some time very little thought was placed upon remedial work from the standpoint of lifting cost. This was due to the fact new fields were being discovered that had large oil reserves and many of the producing fields were still recovering flush production. As a result of this lack of planning, heavy rigs were used in many instances to perform remedial work where the lighter gin-pole rigs would have been equally successful and far more economical. This was partly due to the lack of sufficient reservoir information and a sufficient number of trained reservoir engineers.

At the commencement of World War II steel allocation to the petroleum industry was sharply curtailed, which resulted in fewer wells being drilled. Therefore, in order to meet the large demand by the war department for petroleum products a sharp increase in oil allowables was necessary. This demand caused an increase in price per barrel of oil. Wells that heretofore had been considered uneconomical to produce were now considered to be of commercial value. With the war years came shortages of material and equipment and oil operators were forced to use any type of rig that could be assembled to do remedial work. For the first time since the development of the gin-pole rig this type of equipment was being used to perform work that had previously been done by heavier equipment. Gin-poles, or better known as service rigs, were used to pull screens and liners with tubing. This was done by cutting the liners in short lengths so that the pull would not exceed the yield point of the tubing string.

In December of 1945 service rigs became standard equipment for performing remedial work due to the development of the hydraulic pulling tool by Tod Lawerence. This tool enabled pulling forces in excess of 200,000 psi to be exerted upon stuck liners, etc., without any pull being placed upon the tubing or drill pipe. This was accomplished by applying pressure to the tool by means of a high pressure mud pump at the surface. The pulling force that can be exterted by the tool depends upon the pressure that can be applied internally to the tubing without causing it to rupture. Service rigs with the aid of hydraulic pulling tool are equipped to perform operations that were once only possible with the heavier rigs.

Since the end of World War II the ever rising cost of labor, equipment, and material has resulted in a sharp increase in lifting costs. At the present time, fewer and fewer prolific oil fields are being discovered and the major fields that have been producing over a period of years have reached the point where secondary recovery work is necessary in order to maintain production. As remedial work affects lifting costs, oil operators are becoming more conscious of the cost required to produce a barrel of oil. Therefore, regardless of whether the well was completed years ago or has been recently completed, efficient production methods are necessary to derive

the maximum revenue from it in return for the investment made. In accomplishing this the use of proper equipment is an important feature. The operator must give close consideration to the selection of well pulling equipment and methods necessary to meet the requirements of the field where they are to be used. Paramount qualities to be considered in the selection of this equipment should be safety, efficiency, and economy.

The operator with his thorough knowledge of the well's condition and what is required to perform work prepares a well workover schedule, selects proper type of rig, and assembles material at location. This is very advantageous to the operator as it saves unnecessary transportation and waiting time costs. The sample well workover schedule shown is generally the same used by all operators. It is especially advantageous to the contractor for with it he can plan his work and carry out the procedures in a workman like manner. This type of schedule speeds up the job not only because the contract pusher can get needed materials ahead of time, but also gives the crew a step by step procedure to be used in performing the work and thereby increases their overall efficiency. A contractor needs very little supervision with a properly prepared workover schedule. With the well workover schedule prepared the operator must now select a rig of which he has several choices. Well pulling and workover equipment may be divided into two classes: First, to handle pumping or lifting equipment such as pulling pumps, tubing, sucker rods, etc.; second, for work such as bailing, swabbing, washing out well bore, pulling liners and screens, plugging back, gravel packing, etc. At the present time there are several different types of servicing and workover rigs available; namely, truck or trailer mounted rigs with a 65 or 87-ft mast pole, jack-knife rigs, and various other types of portable mounted hoists and derricks.

A popular type of pulling equipment used by service contractors is a truck mounted tubing hoist equipped with a 65-ft telescoping double pole mast (Fig. 2). This unit is completely equipped for any type of rod or tubing work and is furnished with a crew of an operator and three men. It handles single joints of 30-ft tubing, sucker rods in doubles, and has a hook load capacity of over 100,000 lb. The unit is suitable for performing many of the workover operations that are performed by larger and heavier rigs. Some of the variables which determine the use of this rig are depth of well, number of trips to be made with tubing and type of work over equipment to be used. Normally this unit is operated during the day light hours, and the average time for setting up requires from 30 min to 4 hours, which is one of its advantages. The set up time, of course, depends upon conditions at the location. In the Gulf Coast area the average cost for this unit is approximately $16.75 per hour, less air tongs, mud pump, and transportation.

Another popular pulling unit is a truck or trailer mounted tubing hoist equipped with an 87-ft double pole mast (Fig. 3). This unit uses 2 or 2½-in. EUE tubing and is completely equipped for all workovers performed inside the casing to a depth of 10,000 feet. To obtain maximum efficiency and economy the rig should not be operated below a depth of 7500 ft. This rig is normally operated 24 hours per day and in addition to regular crews is provided with a tool pusher. The advantage of this rig over a 65-ft mast unit is its adaptability to high substructures and ability to pull and stand tubing in doubles. The average set up time varies from 4 to 8 hours in accordance with local conditions. In the Gulf Coast area the average cost for this unit is approximately $18 per hour, less air tongs, mud pump, and transportation.

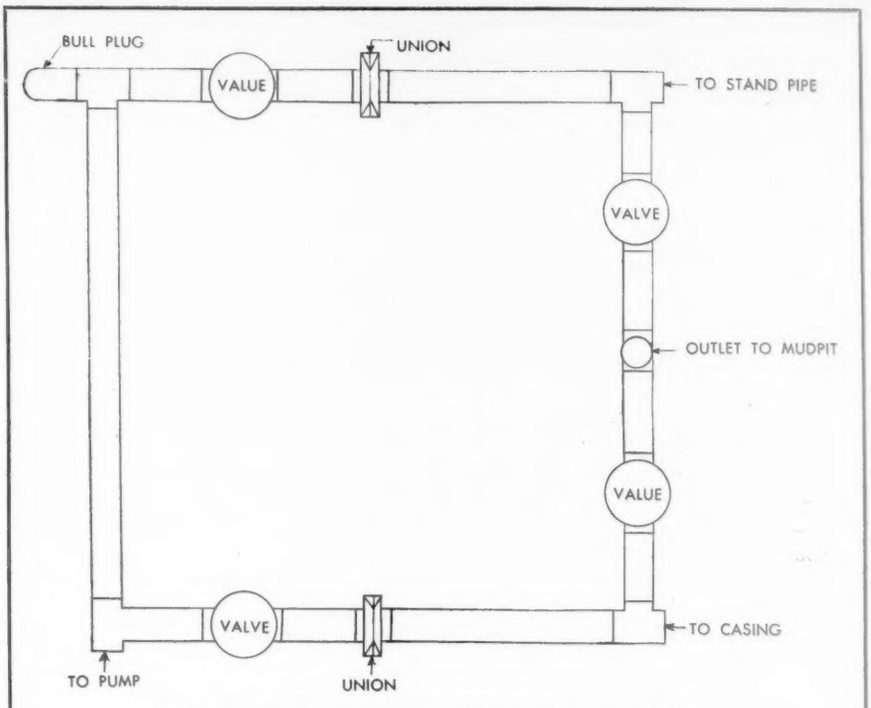


FIG. 5. Schematic diagram of a typical washout manifold, which is a useful tool when reverse circulating.

From the stand point of economy to the oil operators it is advantageous that ground anchors for guying mast type units be permanently installed. This, depending on ground conditions, will effect a savings of from 4 to 8 hours rig time in rigging up and down. Anchor settings for 87 ft mast pole units are standard for any other kind of workover service equipment. Where ground conditions are favorable approximately 4 hours are required to install and remove ground anchors. With the hourly rates charged for workover units considerable savings can be realized on wells where numerous work overs are to be performed during the life of the well. Fig. 4 shows an ideal pattern for anchor settings that is adaptable to all types of rigs. To assure minimum rig up and rig down time oil operators should, wherever possible, install an all weather turn around and road to locations.

Further savings may be realized by the oil operator if a wash out manifold is used. This will eliminate unnecessary work and time required when it is necessary to reverse circulate as is often the case when washing sand from the well bore, and also the danger of sticking the pipe is lessened. In Fig. 5 a diagram of a typical washout manifold is shown.

Whenever it is necessary to use oil, mud, or salt water for working over a well it would be advantageous to use a steel mud tank in preference to an earthen pit. This would eliminate trash from getting under mud pump valves and contamination of washout fluid, and also possible damage claims.

A problem that confronts service or workover rig contractors is the determination of the number of hours per day a workover rig must be operated before a 10 per cent profit on investment can be realized. This can be done by dividing the net profit, after all bills and taxes have been deducted, into the total amount of money which must be earned before a profit can be realized. The result would be the number of days which a rig must operate before a profit can be made. As it is possible for approximately $48,000 to be spent to obtain a 65-ft mast rig complete at present day prices, and using a rate of $16.75 per hour plus $36.00 per day for a mud pump, a total of 276 ten-hour working days per year must be worked before a 10 per cent profit can be realized by the owner. As a comparison it is easily possible for $75,000 to be spent to obtain an 87-ft mast rig complete at present day prices, therefore using an hourly rate of $18 for the rig, plus $36 per day for a mud pump a total of 399 ten-hour working days must be worked before a 10 per cent profit can be realized by the owner. As it is obvious that a 10 per cent profit cannot be obtained by working this rig 10 hours per day for

Well Workover Schedule

Well No. *48*. Lease, *John Doe, Et al.* Field, *Green Bay*. Area, *Houston*.

Autho. No. *9999*. W/O No. *AZ-49*. Contractor, *Moore Petroleum Service*. Rig No. *4*.

Type of Workover, *Plug Back and Test Higher Sand Section*.

Elevation, *12.30* Ft. From *K. D. B.* To *Top of Oil String Flange*.

Total Depth, *7008'*. PB TD, *6486.20'*. ..... " OD Screen From .....

To ..... Size & Type Screen Packer .....

Perforations From *6278'* To *6298'*. Shot by Jet ..... Bullet, *X*.

10¾" OD *40.50* #/ft. Surface Casing set at *1528.22'*.

5½" OD *17* #/ft. *J-55* Grade Oil String Casing set at *6557.15'*.

Electric Log: Yes *X*. No ..... Gamma Ray Log: Yes ..... No ..... Neutron Log: Yes ..... No .....

189 jts of *2⅜"* OD *8* Thd *4.70* #/ft. *J-55* Grade Tubing in Well.

Bottom of tubing @ *5862.86'*. Type Packer, *None*. Top of Packer @ .....

Rods *⅝", 114; ¾", 116*. Pump No. *547*. Seat Nip. @ *5794.55'*.

Precautionary Measures Desired: *57 Jts 5½" OD 17# from 6557.15' to 4684.87'. 144 Jts 5½" OD 15.5# 4684.87' to top.*

Procedure:

1. Pull rods and circulate well with field salt water.
2. Lower tubing and check for fill.
3. Run Gamma Ray Neutron Survey.
4. Run retrievable cementer and squeeze perforations 6278-98 (El measurement) preceding cement w/500 gallons Dowell acid.
5. Run 4¾" rock bit and face off plug.
6. Perforate for production 5½"OD casing from 6266'-72' EL measurements.
7. Run pumping equipment and test.
8. If well sands up, sand control measures will be prescribed according to degree of "sanding" and the sieve analysis of the sand.

365 days it will be necessary to place it on a different working schedule. This would be possible if the rig were placed on a 24-hour a day basis. These figures are based on an eight year depreciation schedule and do not include any major replacements that might occur or allow for any profits to be put back into the business for improvements, expansion, etc.

In choosing a rig one will only get what one pays for and money is not always saved by choosing the cheapest rig in the 65-ft, 87-ft, or any other class. The type and size of rig used and quality of the men operating them will have a definite bearing on the hourly price to the operator. Sometimes a rig having the lowest hourly rate will actually cost the operator more because a greater number of hours are required to perform the work than would have normally been necessary.

Many factors must be considered by both the oil operator and the service rig contractor before a well can be reworked with maximum efficiency and at the most economical cost. As lifting cost is the deciding factor in the production of oil today, the oil operator must make certain that he is using the best techniques and procedures, and that these techniques and procedures are being carried out by the contractor.

The service or workover contractor, while not responsible for techniques and procedures used in working over wells, is responsible for carrying out instructions in the safest, most efficient, and economical way. ★ ★ ★

API Production Men Hear Outstanding Speakers at District Meeting in Fort Worth

More than 1000 executives and technical men from the Texas, New Mexico, Louisiana, and Arkansas oil areas attended the Southwest district meeting of the American Petroleum Institute's Division of Production in Fort Worth recently.

Four prominent speakers addressed the general session. They were Congressman Lloyd M. Bentsen, of Texas; F. H. Willibrand, manager of production, Sohio Petroleum Company, Oklahoma City, Oklahoma; Burt Hull, chairman of the board, West Coast Pipe Line Company, Dallas, and Lyon F. Terry, vice president, Chase National Bank, New York City.

Rep. Bentsen's talk was a "Report to the Stockholders." Willibrand discussed "Engineers as Supervisors and Managers," and Terry, "Valuing Oil and Gas Properties." Hull gave in detail some of the progress made so far in planning the projected $95.000,-000 crude oil pipe line from Wink, Texas, to the Pacific Coast, and its relationship to demand for Permian Basin crude.

Two Citations For Service were presented to Harold Denton, of Sun Oil Company, Beaumont, and Bruno Schabarum, of the Carl B. King Drilling Company, Midland, Texas. The Schabarum citation was presented posthumously. The Citations are given in recognition of outstanding service to the district and were presented by John G. Pew, of Sun Oil Company, who is the API vice president for the Division of Production.

Papers presented at the technical sessions, and their authors are as follows:

"A Drilling Fluid for Use in Drilling High Temperature Formations," T. E. Watkins, Magnolia Petroleum, Dallas; "Recent Developments in Gel Cementing," B. E. Morgan and G. K. Dumbauld, Humble Oil and Refining, Houston; "Lost-Circulation —A Major Problem in Exploration and Development," J. M. Bugbee, Shell Oil, Houston.

"High Pressure Gas Injection—Mechanism of Recovery Increase," R. L. Slobod and H. A. Koch, Jr., Atlantic Refining, Dallas; "A Review of Gas Injection in the Limestone Fields of West Texas," P. E. Fletcher, Atlantic, Midland; "A Discussion of Some Controversial Aspects of Water Flooding," G. L. Buckles, Buckles and Hostetler, Monahans, and Marsh Watson, Amerada Petroleum, Midland.

"Methods of Participation in Unit Agreements," E. B. Miller, Jr., Tide Water, Houston; "Current Drilling Practices in West Texas," David Johnston, McCamey, and W. R. Johnston, Midland, both of Humble; "Gas Oil Ratio Controls in Thin Oil Columns," Robert C. Randle and Jacques H. Marchal, Magnolia Petroleum, Falfurrias.

The oil men were welcomed to Fort Worth by the mayor, and E. N. Van Duzee, of Shell Oil Company, New Orleans, responded on behalf of the Southwest district.

F. E. Hatfield, of Gulf Oil Corporation, Fort Worth, is chairman of the general arrangements committee. Other committee chaimen are as follows: Program, Louis F. Davis, Atlantic Refining Company, Dallas; entertainment, S. J. Iverson, Iverson Supply, Fort Worth; registration, Ray Elner, Kobe, Inc., Fort Worth; housing, Roy T. Durst, Rowan Drilling Company; publicity, W. L. Ambrose, Cities Service Oil, Fort Worth.

Rock-Scaling Releases Trapped Oil

Depositional matrix on the well face retards production particularly during the later stage of operations but the problem can be solved

F. R. COZZENS*

Abstract

Composite elements of reservoir structure that undergo disruption during the completion and maintenance of an oil well are indirectly responsible for a great many plugging problems affecting production. The more soluble fractions of these elements are conveyed to a well by incoming fluids, and readily consolidate at the exposed face of the pay-formation. Resultant changes in face-composition can gradually build up a pressure differential and vary temperatures, and so a suitable base for waxes, salts, and other sedimentary deposits is provided. Oil thus becomes trapped behind the formation-face, and can be released only by scaling-off or eradicating the affected lens of rock. Required scaling is now being accomplished by (1) heating units; (2) nitroglycerine, and (3) reactive chemicals. Practical applications of these agents are described in the text.

Displaced Elements

DESPITE more than 50 years of progress in developing measures for recovering oil, one is still confronted with wells that have been depleted to their economic operating limits, while the content of oil in the surrounding reservoir would not warrant abandonment. Such premature depletions, including wells that reach the stripper stage too quickly, are not always due to insufficient driving energy, or to its faulty distribution through the reservoir as was formerly believed. Quite often, an adequate reserve of pressure exists in the reservoir, but is "bottle-necked" at a well-bore by sedimentary materials that were transported by incoming fluids. When a pay-formation around a well-bore is fractured, perforated, or otherwise disrupted in the effort to obtain oil, certain segments of structure disintegrate so that a variety of constituents, principally clays, carbonates, and trace-minerals are released from their physical binder. As normal drainage is towards the well where the disruption originated, the released elements are motivated to that destination by either water or oil. Upon reaching the well-bore in the form of residue, some of the displaced elements settle out and consolidate at the face of the pay-formation. In a practical sense, they fuse into the face, actually becoming a part of it until a lens is built up. This lens differs considerably in composition from that of the parent reservoir. As displaced elements gradually occupy pore space along the formation face, resistance to incoming fluids is increased, temperatures become unstable, and a favorable environment is provided for secondary deposits such as wax, paraffin, salt, and corrosive sludges. This process continues to some extent through the entire life of the well, and as the lens of formation-face becomes more affected, less and less oil reaches the well, until eventually a premature depletion or a very low-bracket producer results.

*Equity Oil and Gas Company.

Obstructed Lenses Revealed

Composite variations between well-bore and reservoir are present to some extent in practically all types of petroliferous rocks, but are especially pronounced in oil-bearing sandstones where the content of calcium and allied carbonates ranges from a trace to less than 10 per cent. In affected bore-faces, located in such reservoirs, however, the content of calcite, barium, etc., often exceeds 30 per cent with a rock porosity of near zero. In limestone reservoirs, affected bore-faces generally reveal a preponderance of clays, which accounts for the so-called "mudding-up" of many low-bracket wells. In reservoirs of conglomerate structure, it is common to find dense infusions of silt compounds in the bore-face make-up. Particularly characteristic of all types of affected rock-lenses is the prominence of silicate, iron and magnesium salts, and similar corrosive derivatives.

Dissimilarities in composition between formation-face and parent reservoir are readily revealed by analyzing a segment of face-lens, and comparing the analysis with that of a core taken from the reservoir, some 50 to 200 ft distant from the well. Such comparisons will also reveal dissimilarities in weight, color, and texture. The lens sample is generally heavier, darker, and more compact and consolidated. Fluid saturation tests made on the samples, commonly showed an oil-content of less than 5 per cent at the bore-face, while the reservoir cores carry an oil potential of 25 to 40 per cent, which pointed to the fact that a quantity of oil was trapped behind the formation-face. To release this oil, and bring the well back into economical production, primarily it is necessary to destroy the affected lens of rock. This can not be accomplished with scrapers or swabs, or by the use of cleaning preparations. To be effective the agent employed must cauterize or shock the rock-face to an extent that will cause the affected surface to scale or peel off without undue caving of the formation. Three practical agents fulfill these requirements, and they are (1) heating units; (2) nitroglycerine, and (3) reactive chemicals.

Heating Devices

Field tests, made upon cores taken from various types of reservoirs, have shown that certain constituents of rock will disintegrate to the scaling point at temperatures of less than 200 F, while other constituents are capable of withstanding temperatures far in excess of those that could be attained in an average oil well. It has been proved, however, that when heat is transmitted through fluids to the rock-face for a given period of time, disintegration occurs at a lower temperature, and that the more resistant constituents are loosened from the parent rock by detergent actions of the hot fluids. This is the principle most generally followed in rock-scaling, and the favored agent for its application is a down-the-hole heater, preferably of the electric type.

Electric units for well-heating purposes are now available in several designs, and most types are equipped to operate either on single or three phase a-c field power or portable generator. Installations can be made by local field electricians, and the operator may, at his discretion, choose a model for make-up with tubing or string of line-pipe or one which is lowered by cable into the well after the tubing is removed.

The operating procedure, after the bore has been pumped or bailed dry as possible, is to lower the heater to the bottom of the well or to the base of the pay-formation if the well is provided with a pocket. Bore space from the base to the top of the pay-formation is then filled with oil, preferably gasoline treated, or blended with a suitable solvent. Energy is turned on and temperature tests by thermometer are made on

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the fluid each hour. Before any noticeable scaling action occurs the fluid must register a minimum temperature of 170 F from base to top of the pay formation. This minimum must be held or increased for a continuous period of 8 to 10 hours, after which, the electric unit is withdrawn and the heated oil and residue pumped or bailed out. Close examination of the residue is essential, and if the content of sediment is scanty (as determined by bucket samples), the heating process, with fresh fluid, is repeated for a second period of 8 to 10 hours. One or two such treatments, providing temperatures have been held reasonably uniform, are generally sufficient to clear the formation-face of the average well.

In lieu of electric energy, similar beneficial effects can be obtained by the use of gas or gasoline burning heaters supplied with oxygen from the surface. Oxygen and the necessary fuel are fed to the burner through a string of small diameter line-pipe. These devices, however, are more complicated, and require the supervision of a skilled operator. Only such types as will function efficiently in fluids can be recommended for rock-scaling purposes and the device must be capable of providing fluid temperatures of at least 170 F.

Nitroglycerine

Where excessive heat is required or where liquid temperatures can not be held sufficiently uniform in affected wells, the most practical corrective agent is nitroglycerine. This agent is especially favored for use in formations where the pay-zones are separated by beds of shales, and spacers can be utilized through the impotent areas, and both shock actions and gaseous heat can be directed against the affected lens of pay-rock. The treating procedure is to use a small diameter shell (3-in. or less) in a length sufficient to reach from base to top of the pay formation, spacers being used in the shell make-up if, and where necessary. The shot concentration generally required is ½ qt to 1 qt of liquid nitroglycerine, or its equivalent in solidified form (gelatin, nitro-gel, etc.) to each linear foot of pay-rock. A shot concentration of this strength is not meant to alter the pattern of drainage already established in the well, but is designed to expend its force locally upon the face of the formation rock.

No stemming is required for rock-scaling charges and consequently there is less risk of damages to casing. As a precautionary measure, however, the top of the shell should rest at least 2 or 2½ ft below the casing. It should also be verified that no tubing, or broken sections of pipe exist in the bore and it is advisable to bail the well as dry as possible before the shell is run.

One treatment with nitroglycerine is generally sufficient to eradicate the lens of affected rock, but as the quantity of residue is greater than when mechanical heating devices are used more time is required for cleaning out the bore. Use of a sandpump or suction bailer is usually necessary in these wells.

Reactive Chemicals

Affected wells located in shales, conglomerate, or loosely cemented formations often respond more readily to the use of chemicals, such as lye-aluminum, calcium carbide, and commercial preparations of similar nature that react in the presence of water to form heat. When used in prescribed quantities, in relation to bore-capacity, these agents are capable of creating and maintaining temperatures ranging from 170 to 200 F, and have beneficial detergent effects upon the face of the formation. The misguided use of chemicals, however, can result in an expensive clean-out, due to sludge deposits and excessive caving of the bore-walls.

The most widely approved procedure is to fill the bore with crude oil to within two feet of the top of the pay formation. The chemical, or chemical combination, is then introduced dry with just enough water added to the oil within the bore to cause maximum reaction; the general formula is ¼ gal of water per pound of dry chemicals. For the average well having a pay formation face of 20 linear feet or less the required dosage is from 100 to 300 lb of dry chemicals. The dosage is introduced into the bore a few pounds at a time until the fluid testing thermometer registers 170 F or higher. Precautions should be taken against the fumes or gases released during chemical reactions in the bore. These gases are nauseating and often highly inflammable. Once the required temperatures have been built up they should be maintained in the reacting fluids for a period of six to eight hours and fresh chemicals are added if necessary. Afterwards the residue must be bailed out while quite hot, otherwise a sludge will settle out and congeal in the base of the bore.

Follow-up Measures

Effective rock-scaling releases the primary elements, such as clays, calcium, and mineral deposits that have fused or consolidated with the formation-face, and also the adherent secondary elements such as waxes, salts, and organic growths. It is essential that all such residue be removed immediately from the well. A thorough bailing or pumping-out should be followed by several washings with carbonated water, brine, mild solutions (6 per cent or less) of hydrochloric acid with inhibitors, or water to which a germicidal agent has been added. No well should be put back into production until the washing fluid is returned to the surface reasonably clean. In stubborn cases an agitator or fluid jetting device proves beneficial in clearing the bore.

In washing out wells where packers do not interfere a much favored method is to pour a quantity of washing fluids down the casing-tubing annulus, until the bore interval of the pay formation is nearly filled. The flow line is then connected to discharge into the casing-head. The pump is begun and the fluid circulated through the well for three to five hours, after which time the flow-line is disconnected and the fluid pumped out. Following the rock-scaling procedure, many operators believe that circulated washings should be conducted at least once during a 90-day period, and solvents should be used in connection with the washing fluids. The objective is to prevent solidification of incoming sediment so that it can be emitted normally from the well through the pump.

Release of trapped oil by methods of rock-scaling restores normal fluid movement and results in a more uniform depletion of the reservoir. Fifty extra barrels of oil from a reclaimed bore generally repay the cost of the average rock-scaling job. The productive cycle is lengthened, remainder of the output is of course additional oil that would have remained in the reservoir had the well been abandoned. * * *

New Recovery Method Increases Flow

Encouraging findings for increased production of oil in both sand and limestone formations were reported at the spring meeting of the Mid-Continent district of the Division of Production, American Petroleum Institute, Tulsa, Oklahoma.

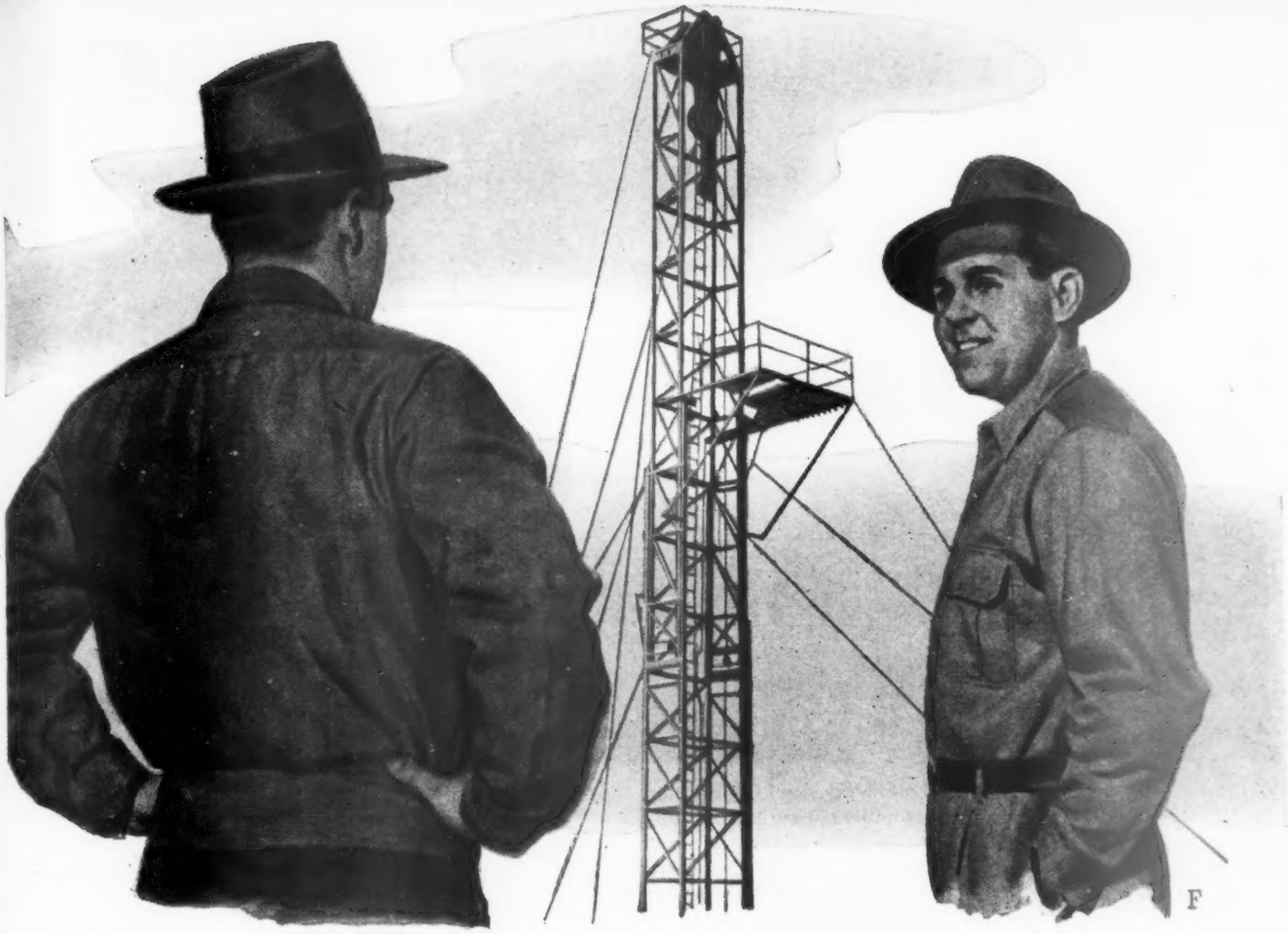
C. E. Clason and Wayne F. Hower, Halliburton Oil Well Cementing Company, presented a paper entitled "Removal of Flow Restrictions in Well Completions" at an afternoon group session of the meeting.

"Increased production in either new wells for initial production or an established well to regain production, has been noted through the use of a unique mixture of dilute hydrochloric acid and an organic sulfonic acid which removes aqueous and bentonitic blocking materials," they asserted.

"In the past 18 months, hundreds of wells have been treated with successful results," Clason and Hower said. They warned, however, "The chemical mixture will be of benefit only when a blocking condition of aqueous and bentonitic materials exists."

The method is not a cure-all for every production difficulty, they explained, but it is a "valuable link in the chain of processes that are helping to set new records for the production of oil."

The chemical action produces a series of physical changes to accomplish the breaking of water blocks, dispersal of muds, the reduction of the size of water-swollen bentonite particles and the destruction of emulsions in the vicinity of the well bore, in order to re-establish as much of the normal permeability of the structure as possible, they pointed out.



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High Yield makes a superior drilling mud for use in spudding, drilling core holes, and workovers where a low weight mud is desired with proper viscosity, gel strength and good wall building properties. Processed under exacting laboratory control, High Yield Drilling Mud is resistant to salt and other contaminants often present in make up water. It has proved to be a valuable additive to high pH-lime muds for control of viscosity and filtration properties. High Yield Drilling Mud makes approximately 50 bbls. of 15 centipoise mud per ton and is one of the most economical materials for building a balanced mud. Ask your Magcobar engineer or nearby Magcobar Dealer how you can save long water hauls and rig time with High Yield Drilling Mud.

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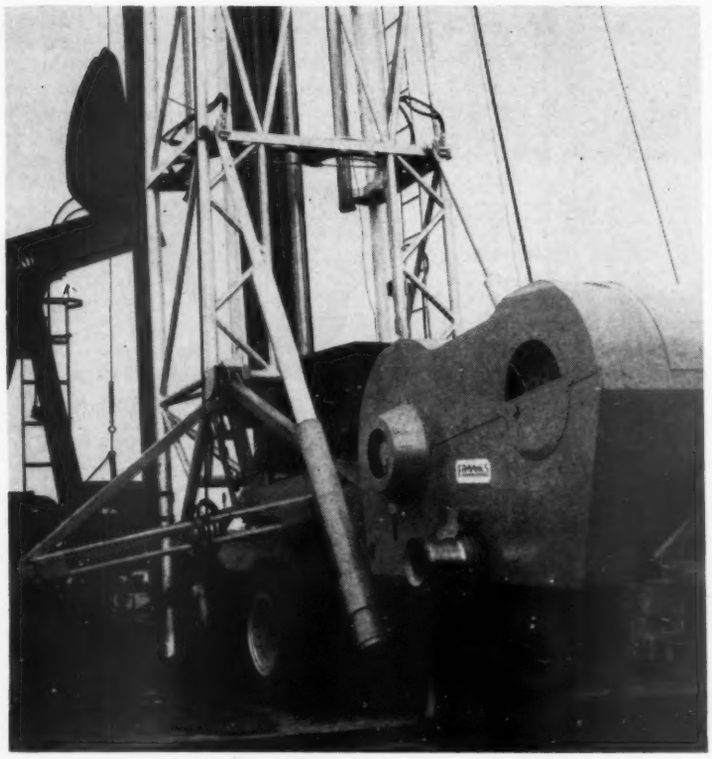

At the lower right can be seen the oil misting device for lubricating the chains. Cathead and rams are shown also. At the top of the latter are the valves that provide a safety check in either direction.

Operator is at the console while floor men make up the tubing. Extra connecting hose on the ground shows how the position of the console can be placed anywhere within a radius of 25 feet from the derrick leg.

New Deep Well Servicing Rig for California

Production operators require a unit with mobility, rapidity, and efficiency so as to carry out successful jobs

RICHARD SNEDDON†

THERE is being subjected to final testing in the Los Angeles basin at the present time what might properly be termed a "custom built," self-propelled, well-servicing rig[1] that was literally "tailored" for use in California. Although it complies with every pertinent edict of the state highway code as to weight and dimension, it is nevertheless heavy enough and has capacity enough to perform well-pulling service or other remedial work in the state's deepest wells. There is nothing flashy or spectacular about this unit. It was built along strictly utilitarian lines, and every item in its makeup is based on sound engineering principles or is born of actual experience in well maintenance and repair work.

The rig, which is the product of a nationally known and reputable manufacturer, is in effect a modification of prior models built by the same company, but certain changes, improvements, and an enlargement of capacity without sacrifice of mobility or maneuverability, invest the entire development with a special interest for production foremen and superintendents. These adaptations are the results of some three years of research, supplemented by conference and consultation with authorities in all phases of servicing rig design, construction, and operation.

The individual features of the total assembly have been discussed *ad infinitum*, both in form and function, with oil company engineers, automotive engineers, technologists, experienced well-pullers, and even staff members of the California Highway Commission. All conceivable contingencies have been considered, and on the basis of these deliberations a compact, safe, easily maneuverable, and fully effective package has been designed and built.

In order to keep within the required weight limitations without affecting the ruggedness of the hoist or the efficiency of operations, it was necessary to eliminate all dispensable components. The conventional tractor, for example, was abandoned and the rig components were assembled in a carefully arranged entity that moves on four axles, two of which are driving axles, deriving their power from the same engine that powers the drawworks, thus obviating the need of a separate automotive plant for propulsion.

This saving of weight is typical of the effort that was exerted to conserve space

†Editor, Pacific Coast.

[1]Franks "Clipper Hoist."

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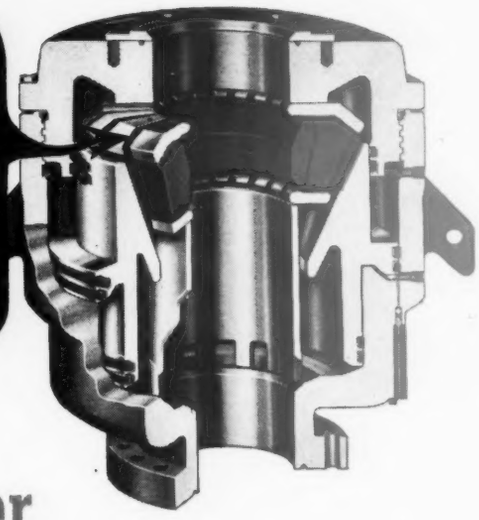
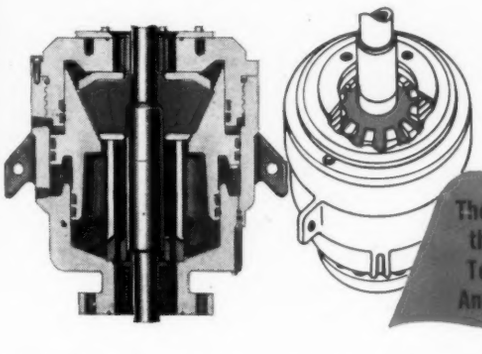
This steel fist in a rubber glove
STRANGLES BLOWOUTS
no matter what is in the hole!

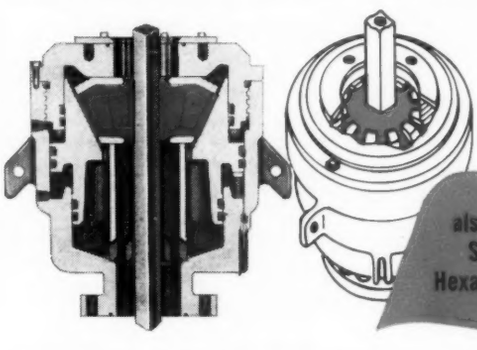


HYDRIL Type "G-K" Blowout Preventer

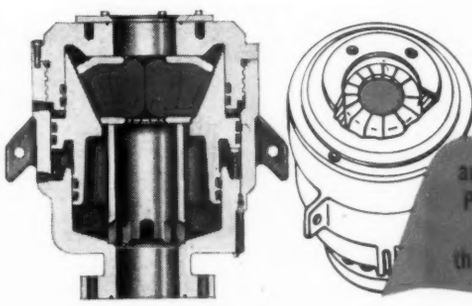


Made of high-quality compounded rubber packing material reinforced with flanged steel ribs, this cartridge-type packing unit is the heart of the dependable Hydril Type "GK" Blowout Preventer.

Extremely flexible in operation, the cartridge-type packing unit packs off pipe and tool joints, yet it is quickly adjusted to permit rotating the pipe, stripping pipe and joints... or opened wide to pass bits and other large tools.



Owing to the unique design and construction of the packing unit, it packs off just as tightly and safely around square and hexagonal shapes as around tubular ones.



Even if there is nothing at all in the hole, the Type "GK" Blowout Preventer will seal it effectively against mounting pressures. Pressure from the well actually helps to pack it off more tightly!

And Hydril Type "GK"... the world's simplest and safest Blowout Preventer... is the simplest and safest to operate. For further details, contact your nearest Hydril representative today, or look up Hydril in the Composite Catalog.

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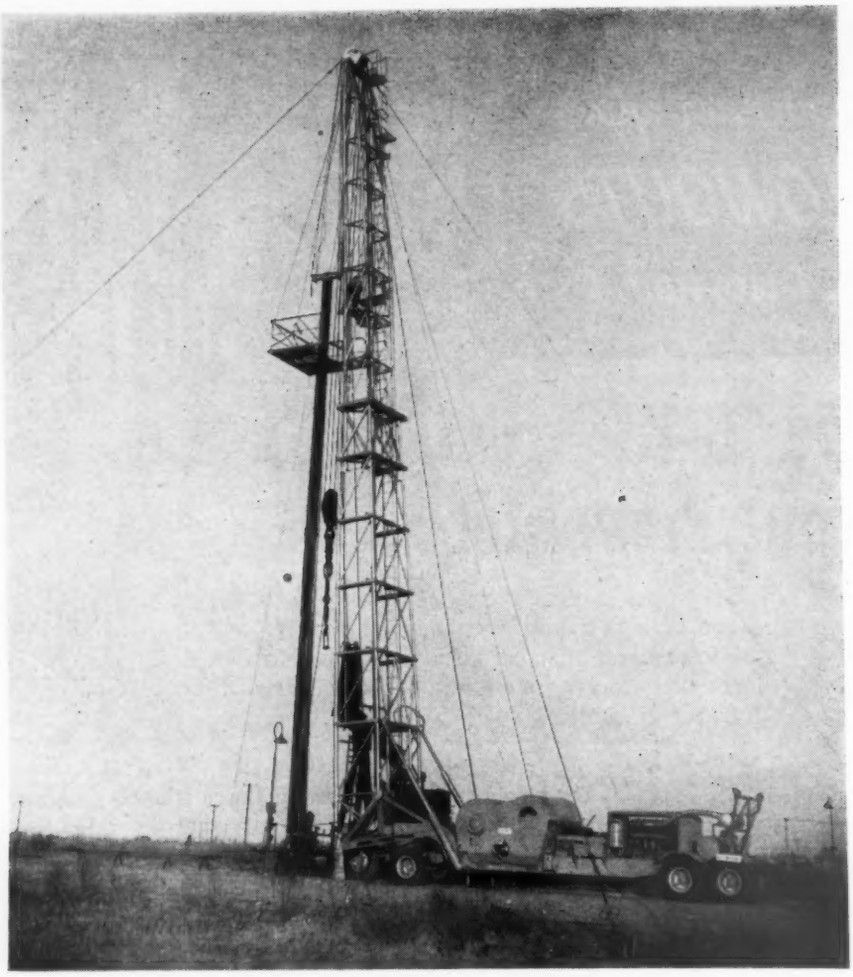

The rig is in operation with rods suspended in special comb-type hanger.

Here is shown the outrigger support of the mast and frame with the cab covered over to keep windshield from being splattered with drippings from the rods. The rods are tied back to the derrick leg while the tubing is being pulled.

and materials throughout and to keep the ratio of available horsepower to weight as high as possible within the permissible dimensions. The total rig as it stands has the greatest legal gross capacity of any existing 4-axle vehicle, a circumstance that was brought about by substituting for the conventional tractor set-up, a pair of axles and a quarter tractor frame, and in addition to eliminating the power plant as already mentioned, also discarding some 75 per cent of the frame, most of the sheet metal, and a number of other non-essentials.

The maneuverability of the vehicle is evident in the fact that its turning radius is comparable to that of a standard truck. The chassis is of the alligator type with adjustable outriggers hinged to the forward derrick support. When swung out with 18 ft spread these outriggers, strongly supported with hydraulic jack legs, adequately stabilize the derrick for raising and extending, allow greater stability with less guying for general operations. With the unit in traveling position, the outriggers swing into side of frame, meeting highway regulations. They can be folded into travelling position or opened up for field work within a few seconds. The rear bogie has a double reduction tandem-axle assembly with eight aluminum wheels. The front bogie, consisting of one steerable axle and a trailer axle, has six aluminum wheels and air-actuated brakes.

The power drive is from a rear-mounted, 6-cylinder diesel engine, with a rating of 254 hp, through a torque converter and 3-speed full-torque shifting transmission to the rear bogie, with a declutch in the transmission to the bogie drive. A governor assembly controls the full load setting at 1800 rpm, and there are vibration dampeners, lube filters, engine ventilators, and other accessory devices to assure efficient operation for the longest possible time.

The torque converter is a single-stage polyphase type with built-in oil pump and taps for tandem operation with full torque shifting transmission. This latter is further provided with a solenoid selector valve to permit remote control of the main drum from a console which is equipped with connecting lines that permit it to be placed anywhere within a 25-ft radius of the front corner of the vehicle. Finger tip response reduces the entire operation to its simplest dimension; permits the head well-puller to choose the site from which he can best and most safely view the pulling operation; and introduces a general measure of safety that is distinctly worthwhile.

The rig features a double drum, final friction-drive hoist of larger capacity than other self-propelled units made by the same manufacturer. It is driven through a propeller shaft to the power take-off. The main drum brakes are 46 in. in diameter by 10 in. wide, water cooled, and with a spooling capacity of 4820 ft of 1-in. line or 15,230 ft of 9/16-in. line. These are remotely operated, air-hydraulically. The sand reel is equipped with 37/8 in. diameter by 8-in. wide brakes. These are mechanically op-

Finishes what it starts

From site preparation to final clean-up, no single piece of equipment is as useful as a Caterpillar D6 Tractor equipped with a No. 6A Bulldozer.

"We use Cat* machines from 'the cradle to the grave'," says Lyle Ostrander. "Since we bought our first piece of Caterpillar equipment 15 years ago, we have tried to standardize on them."

Mr. Ostrander is pipe-laying foreman for Otis Eastern Service, Inc., Wellsville, N. Y. The company's handy, rugged D6 is shown filling around valve boxes after a drill rig has been moved at Lock Haven, Pa.

The D6, equipped with a bulldozer and a Hyster 6N Winch, is used by Otis Service to lay pipe, clear out for locations, and for cleaning up after drilling and abandoning wells.

The talented Cat angling-type Bulldozer is master of any job it tackles. Deftly taking large loads, it holds them on the blade and puts them where needed. The blade, sturdily built of five box sections, can be angled into three positions by one man.

Your Caterpillar Dealer will be happy to give you a demonstration of this versatile big yellow rig. You'll find there's real profit in Caterpillar yellow.

Caterpillar Tractor Co., Peoria, Illinois.

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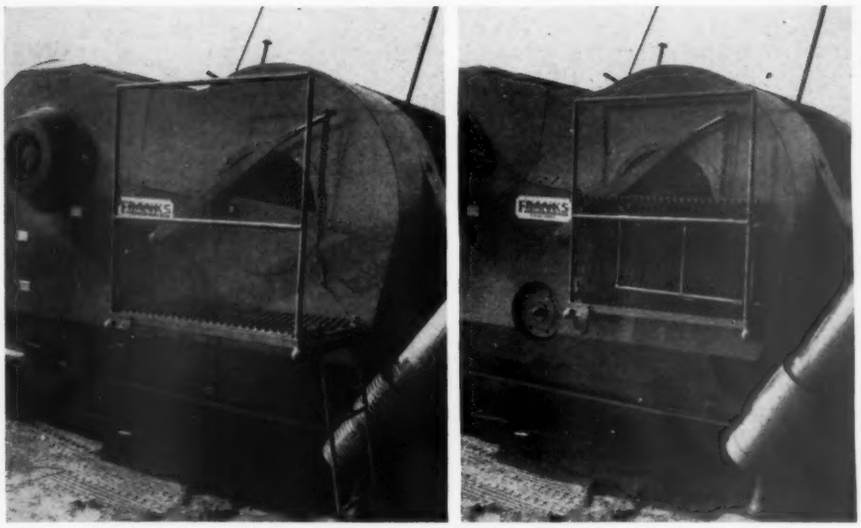
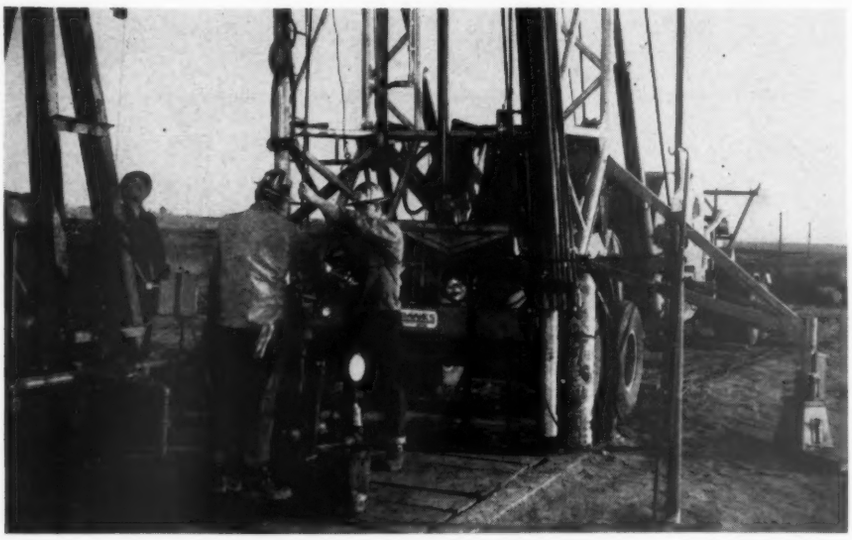


A view of operating platform for rear drum or sand reel shows forward position, giving clearer vision of well head and line spooling on drum. In the center picture platform has been retracted for traveling.

View of cathead shows safety catline guard and emergency safety control lever.



Working view of front of unit while running rods shows outrigger stabilizer, working clearance on floor with rods tied back and movable control console placed conveniently for clearest vision and safety.

erated, but are hydraulically equalized and adjusted. Spooling capacity is approximately 11,000 ft of 9/16-in. line.

The power take-off consists of a right angle hypoid gear box with shaft extension to the drive hoist drums. It has a reduction rate of about 1.7 to 1.0 and is also used to drive the cathead. The hoist is operated by dual chain drives, and these together with all the principal working parts, are automatically pressure or flood lubricated, with lubrication points being grouped for easy and speedy access. The cathead is driven by an extension gear box shaft and has a safety cut-off at the cathead position. Indeed, safety has been a prime design factor all the way in the development of this rig.

The hoist, integrally mounted to the chassis, is fully enclosed and shielded as are all moving parts, and the rear drum or sand reel is equipped with working platform of retractable type.

The derrick is slightly over 93 ft. It is a telescoping mast type of exceptional strength and is conservatively rated at 200,000 lb working capacity. It is raised and extended by means of two 2-stage, double-acting hydraulic cylinders with safety checks in both directions. The racking board is folded and unfolded from the ground, eliminating the necessity of sending crew men aloft to perform this hazardous job. The derrick is provided with dual comb-type hangers, which assure concentric support for the rods, and the pedal operated air-lift moves the rods in and out of the hanger, leaving the operator's hands free to latch the elevator and guide the rods.

The mast is provided with ladders and landing platforms from bottom to top with plenty of toe clearance at all points, and as the structure is telescoped, such sections as must be retracted either to comply with transportation restrictions or to improve visibility, are automatically folded. For well servicing operations, the vehicle is headed into the location instead of being backed in as is customary with other units. Thus, it is so easy to spot that, with very little practice, it can be done by any member of the pulling or maintenance crews. It is also worthy of note that the necessary guys are permanently attached to the rear of the vehicle.

There seems to be no doubt that the designers of this rig have achieved some very important objectives. They have produced a mobile well-servicing unit that can be speedily put to work at any location; will handle pulling or remedial work in the deepest wells in California; is simple and safe to operate, and frees the operators of further worry over compliance with state highway regulations. That is rather substantial accomplishment and might end a long time struggle if it weren't for the fact that accomplishment is the goal that drives us to further accomplishment so that, to those who do, there is no comfort, except in further doing. * * *

IBM Machines in Geology

Application of International Business Machines electronic calculator to problems in petroleum geology was demonstrated at the annual convention of the American Association of Petroleum Geologists and the Society of Exploration Geophysicists held here at the Sam Houston Coliseum, Houston, Texas, recently. Used in conjunction with an IBM electric accounting machine, the calculator will perform computations in the interpretation of seismic recordings to find the depth of a reflecting horizon. These calculations, important in the locating of possible petroleum deposits, will be illustrated by special explanatory displays.

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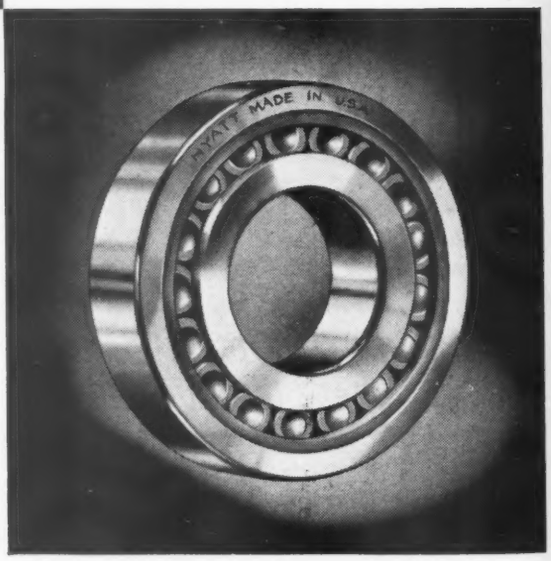

HYATT ROLLER BEARINGS

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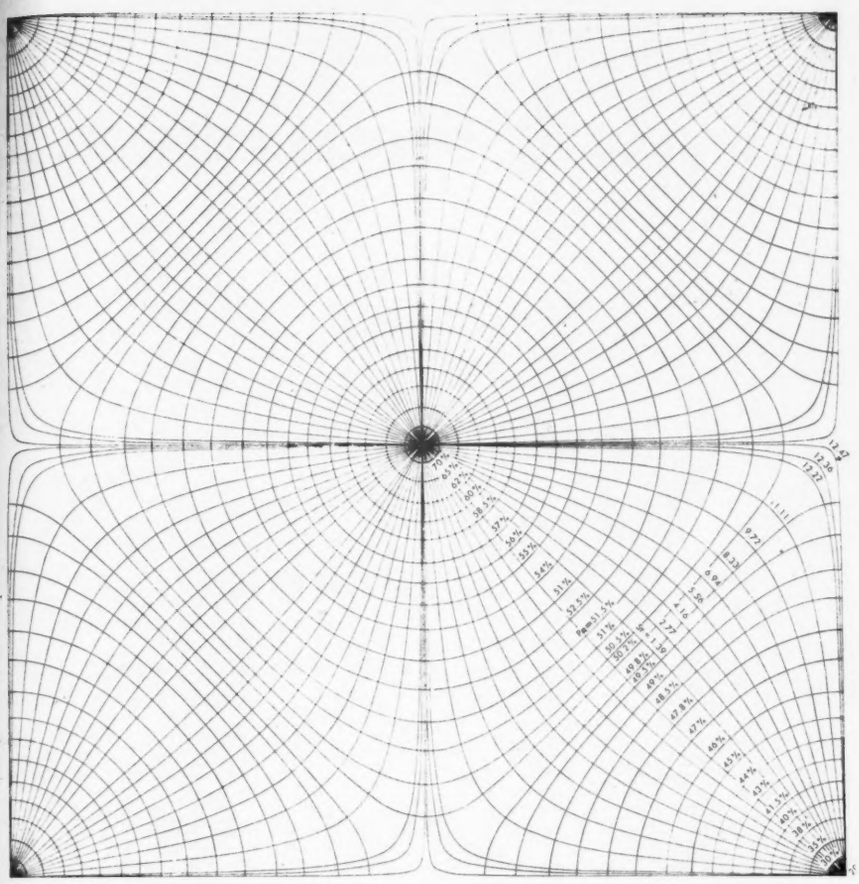

FIG. 1. Five-spot water flood—potential and stream lines.

Determination of Performance Curve in Five-Spot Water Flood

Important practical considerations are water fill up in respect to actual oil production and the break through point

WILLIAM HURST

THE method presented is the formation of an oil seal in a five-spot water flood, and the development of its progress to break through into the producing well. This method is applicable to any configuration of secondary recovery in water flooding. The criterion that permits this development is the displacement of oil by water in the interstitial pore space, and referred to as the displacement factor.

Illustrations for a five-spot water flood are included in this work, and a detailed analysis given. The generalization of the problem facilitates the computations to obtain a realistic portrayal for the growth of the oil seal in the path of the water flood. This is represented by the performance curve which gives the cumulative oil produced as a per cent of the recoverable oil in the formation versus the total water injected, expressed as a per cent of the total floodable void space in the reservoir, Fig. 8. The time for fill-up for the oil seal to reach the producing well, followed by break through of the water flood are also indicated by the amounts of water injected.

EXCLUSIVE

Introduction

Although the literature published for the last two decades on water floods, both in the laboratory and in the field, have been voluminous, it is a significant observation that to appraise property for a water flood project there is little offered in these publications that can serve as a guide or whose approach to the problem could lend validity that would permit its presentation to management. The sum total of the industries' experience has been of a "rule of thumb" procedure, and a great deal of conjecture as reflected by the failures that some of these projects have encountered. The urgency and need for this information in production engineering has necessitated the recreation of the water flood problem from its basic concepts, and it is believed that its importance can serve a useful purpose for future water flood projects, which justifies its presentation here.

What is developed in this paper is a method of deductive reasoning as applied to a water flood program. The criterion upon which the greatest credence is placed is the displacement of oil from the interstices of the pore space by the injection and movement of water in the formation, to form a growing oil seal ahead of the water front, which finally breaks through into the producing well. The paths travelled are the stream-lines between input and producing wells. The displacement of oil by water in the interstices are determined by the recovery factors; such as primary or solution drive recovery, that established the oil in place; which in turn is partially displaced by the injected water as a banked oil column into the residual gas space in the direction toward the producing well by that amount of oil that will yield an ultimate recovery corresponding to water drive. There is no attempt to enter into a discussion of these recovery factors as there is now sufficient data in the literature to make comparison of depleted fields with what

The Author

William Hurst is a partner in the firm of Petroleum Consultants, Houston, Texas. One of the early reservoir engineers in the industry, Hurst is a graduate of Massachusetts Institute of Technology, where he received both his BS and MS degrees. From 1929 to 1941 he was employed in production research by the Humble Company, followed by an association with Core Laboratories, Inc., from 1942 to 1943. He was senior reservoir engineer for Shell Oil Company until 1948, going into private consulting practice before joining Petroleum Consultants.

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may be expected in the reservoir under consideration. Furthermore, laboratory experiments may be simulated to obtain such information, provided conditions are comparable to those that prevail in the reservoir. In essence the primary purpose for this presentation is to offer a method for the prognostication of water flood.

The practical significance of this study is the determination of the time of fill-up that may be expected from the start of a flood to that time when oil will be produced from the output well, and also to establish the break through of water into the producing well in the course of the water flood program. The reference to time as employed here is used only in an abstract sense, as the development of the displacement phenonmenon to the analysis given here, translates time as the total amount of water injected in carrying out the flood program.

Although the problem is applied to a five-spot water flood, no significance should be attached to this specific application, as the five-spot flood merely serves as a vehicle to present the more important phase of displacement of oil by water in the formation. The problem could equally be treated for a line-drive, seven-spot, or the sweep pattern determined by a potentiometric model[2], provided the displacement factor, based on the recovery factors, is identified. For this reason the reader can give perfunctory consideration to the discussion on five-spot water flood, and turn his attention to the more pertinent aspect of displacement. The only requirement for undertaking the engineering calculations from theoretical considerations, is the per cent total area swept versus per cent area processed, corresponding to

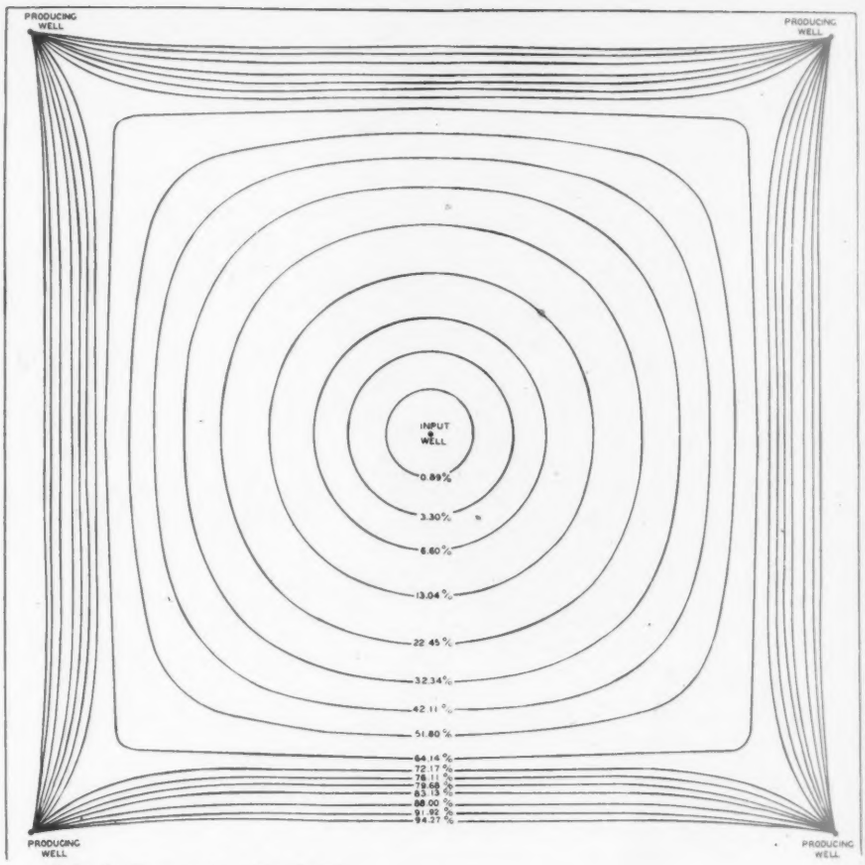

FIG. 2. Five-spot water flood.
Water-oil interface, showing per cent of total floodable pore space.

Fig. 3, and as implied, this could be developed from mathematical analyses, model study, and information already contained in the literature.

Five-Spot Water Flood

The illustrative application for the displacement phenomenon is the five-spot water flood. No attempt will be made in this paper to enter into mathematical concepts, although for purpose of reporting and to make such information available to interested groups the following brief digest of the subject is presented.

Muskat[1] has shown that by the consideration of an infinite array of point sources and sinks, staggered in such a manner as to reproduce the spacing required in a five-spot flood, namely four input wells situated at a corner of a square with a producing well in the center or vice versa, the effect of such a flood can be simulated. The potential distribution is expressed by the relationship given in cartesian coordinates with the origin at the input well, and d the distance between input and producing wells,

$$\Delta P = \frac{q\mu}{4\pi KH}\left\{\log\frac{[\cosh \pi y/d - \cos \pi x/d]}{[\cosh \pi y/d + \cos \pi x/d]} + \sum_{m=1}^{\infty}(-1)^m \log \frac{[\cosh\pi (y - md)/d - \cos\pi x/d]}{[\cosh \pi (y - md)/d + \cos \pi x/d]} \frac{[\cosh \pi (y + md)/d - \cos \pi x/d]}{\cosh \pi (y + md)/d + \cos \pi x/d]}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Where q is the rate of fluid production in steady state flow between input and producing wells, μ the viscosity of the fluid, K the permeability of the formation, and H the thickness of the sand. In this expression natural logarithms are implied.

To determine the fronts or the sweep of the encroaching water it has been necessary to know the direction of the stream-lines between wells in addition to the potential distribution. Inasmuch as the relationship is not available in the literature, this investigator has independently made this development, and the stream-line distribution is expressed as,

with the inverse tangent referred to in radians.

The application of these formulae have permitted the determination of a five-spot water flood as shown by the potential and stream-line distributions given in Fig. 1. This is based on a 20 acre spacing, with 933 ft between wells, or d the distance between an input and producing well, 660 ft. In this illustration the well radius is taken as 6 in. The values reported for the potentials are the per cent over-all drop between the input and output wells, and the stream-lines are likewise given on a per cent basis for the total influx to the input well.

Encroaching Water Fronts

It has been shown by Hurst and McCarty[2] that the establishment of the encroaching front for the displacement of one fluid by another is essentially the solution of a trajectory problem. To express this symbolically, if S_{ST} is the distance along a given stream-line shown in Fig. 1, v the velocity at a point, and t the time, then the interval it takes for a particle to move along this stream-line from the input to the producing well is given as

(See next page)

$$S_T = \frac{q\mu}{2\pi KH}\left\{\frac{\pi}{2} - \left[\tan^{-1}\frac{\sin \pi x/d}{\sinh \pi y/d} + \sum_{m=1}^{\infty}(-1)^m \left(\tan^{-1}\frac{\sin \pi x/d}{\sinh \pi (y + md)/d} + \tan^{-1}\frac{\sin \pi x/d}{\sinh \pi (y - md)/d}\right)\right]\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

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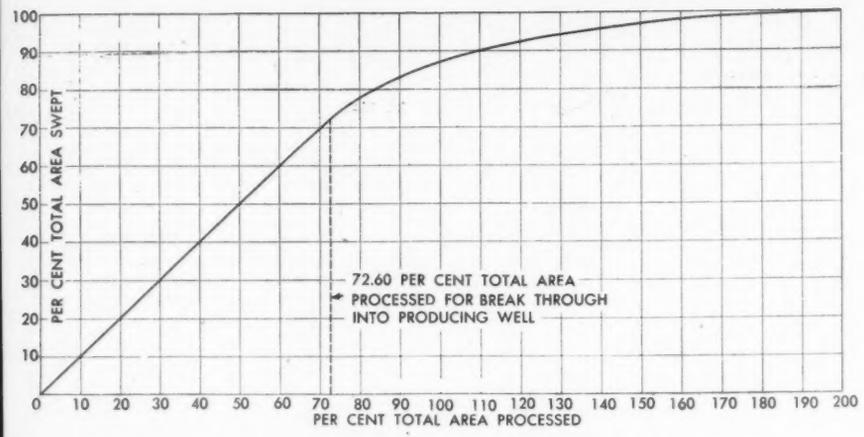

PER CENT TOTAL AREA SWEPT
PER CENT TOTAL AREA PROCESSED
72.60 PER CENT TOTAL AREA
PROCESSED FOR BREAK THROUGH
INTO PRODUCING WELL

FIG. 3. Five-spot flood, per cent total area swept vs. per cent area processed.

$$dS_{ST} = Vdt \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

or

$$t = \int_{o}^{S_{ST}} \frac{dS_{ST}}{V} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The velocity on the stream-line can be expressed by Darcy's law as directly proportional to the pressure drop per unit path of flow, or

$$v \sim \frac{d\Delta P}{dS_{ST}} \quad . \quad . \quad . \quad . \quad (5)$$

and Equation 4 becomes

$$t \sim \int_{o}^{S_{ST}} \frac{dS_{ST}}{d\Delta P/dS_{ST}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Thus, the determination of the time of travel along a stream-line, with the comparable points on all stream-lines joined by a curve, gives the front displaced in that period of the flood.

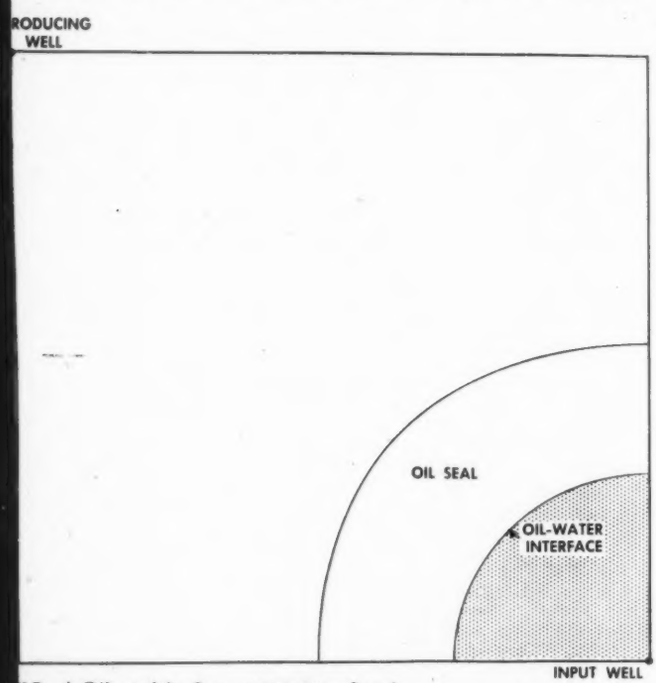
For the problem under discussion, corresponding to the potential and stream-line distributions shown in Fig. 1, the respective fronts swept out by the encroachment of one fluid by another in a five-spot water flood are illustrated in Fig. 2. It is to be observed that although in the early stages of sweep such displacements are radial, these fronts rapidly approach a square pattern prior to break through into the producing well. In this respect the problem is a departure from the previous thoughts on the subject, which assumed that radial flow persisted in a five-spot water flood until fill-up time, when an interference region is reached between adjacent floods, and the floods then become tangential.

The value reported in Fig. 2 is the area swept with respect to the total area contained in the flood pattern, expressed as a per cent, and associated with each front is time determined from Equation 6. As this analysis represents a constant rate flow problem, time is directly proportional to the amount of fluid injected and processed in the flood program. The areal extent or formation volume of pore space processed is indicated by the expanded front, which increases linearly with time until break through into the producing well occurs, to be followed by a decreased rate of encroachment due to the fact that the well now produces some of the displacing fluid. Therefore, in place of time as developed in Equation 6, its equivalent units have been related to the areal displacement in the earlier period to establish the formation volume of pore space processed for subsequent times until the completion of the flood. This is illustrated by Fig. 3, which shows the per cent of the total area swept versus the per cent of total area processed, and it is comparable to similar curves employed in gas cycling.[2,3] Furthermore, this is a generalized curve for a five-spot water flood, as it is independent of the distance between wells.

Displacement

The work hereto presented has followed much in thought with the principles established in the industry for water flooding and gas cycling. The scope of this paper, however, is to present yet another and more important aspect of the problem in water flooding, and that is the determination of the oil seal ahead of the water front for the movement of oil by water in the formation. The time, or formation volume processed, in indicative of the fill-up time that the oil seal reaches the producing well.

The criterion for the analysis is the displacement of oil by water in the interstices of the pore space. As previously mentioned there is no attempt here to enter into a discussion as to how the displacement, or recovery factors, is established from field studies, as this falls within the province of the specialist whose experience, judgment, and knowledge of reservoir behavior must serve



IG. 4 Oil seal in five spot water flood.
.55% total area flooded. Oil seal occupies 14.90% of total area.

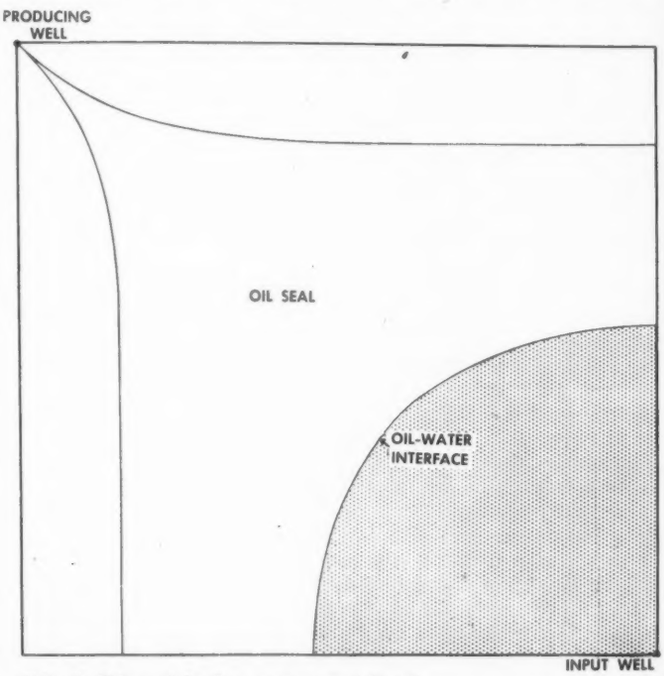


FIG. 5. Oil seal in five spot water flood.
23.82% total area flooded. Oil seal occupies 48.35% of total area.

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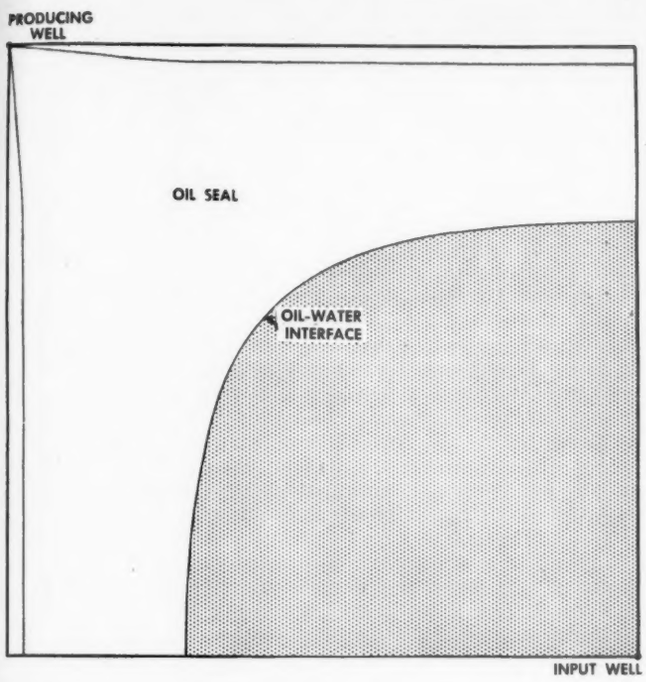

FIG. 6. Oil seal in five spot water flood.
44.61% total area flooded. Oil seal occupies 50.56% of total area.

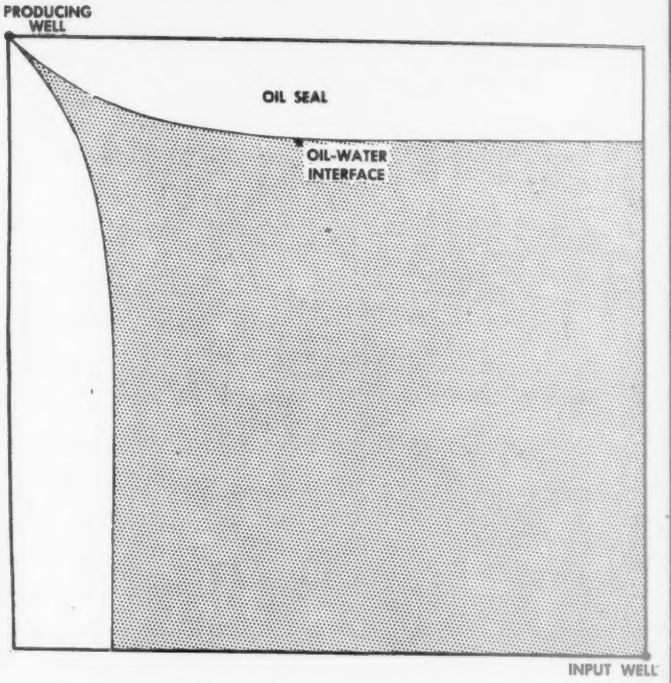

FIG. 7. Oil seal in five spot water flood.
72.17% total area flooded. Oil seal occupies 27.83% of total area.

as the contributing factor in undertaking this study. It suffices, however, for the purpose of this paper to present an illustrative calculation, that simulates the growth of an oil seal ahead of the water in a water flood project.

If the pore space of a sand contains 35 per cent connate water, 50 per cent residual oil saturation, and 15 per cent gas space, established by primary recovery and depletion. Then if it is anticipated that an additional 30 per cent of the total pore space of this residual oil will be recovered by water flooding, which corresponds to the additional recovery expected for an ultimate water drive recovery for the formation, this will reduce the residual oil saturation in the flooded section to 20 per cent with the remainder of the pore space occupied by water. In flushing the sand with water, however, the recoverable oil displaced will be forced ahead into the interstices of the gas space of the adjacent depleted oil sand in the path of the sweep pattern in the direction toward the producing well. Thus, the area formed by the oil seal to the area flooded will be in the ratio of the oil displaced to the volume of gas space, or 30 to 15 to give a ratio of 2:1. If we consider the total areas affected, which are the oil seal and that of the flooded area, with respect to the flooded area, will, give a ratio of 3:1, which in this analysis is referred to as the displacement factor.

The interpretation of the displacement factor with reference to the flow pattern forms the basis for the development of the problem. It has been mentioned that for steady state flow the area swept in the early period is directly proportional to time. Therefore, if one takes cognizance of what is implied by the displacement factor, it will be evident that in this stage of the flood, and prior to any break through to the producing well, the areal extents of the formation swept by the oil seal and water flood with respect to the flooded area from the input well will be in the ratio of 3:1, or expressed in time, gives the relationship that the ratio for the time, and areal advancement, of the gas-oil interface to the oil-water interface is directly proportional to this displacement factor.

This relation applies even after break through into the producing well occurs. To visualize this effect refer to Fig. 1. The stream-lines shown in this illustration indicate not only the paths of travel for the flood, but also give the distribution of the influx for the injected water into the formation, such that between any two stream-lines the water injected will always be contained between these stream-lines and act as a separate flood, although related to the total influx by the manner of distribution. Further, if one considers two stream-lines in which neither front has broken through into the input well, then within these stream-lines the areas displaced by the oil seal and water flood to the water flood must likewise be in the ratio of 3:1. As this is comparable to the previous case, then such areas swept will be directly proportional to time, and it follows that even after break through into the producing well the time for advancement of the gas-oil interface with respect to the oil-water interface will be in the ratio of the displacement factor.

This time ratio, as discussed, refers to those times indicated by the expanding fronts shown in Fig. 2, and corresponds to the areal extent of the formation processed. The sequence for the formation of the oil seal ahead of the water flood in the movement of fluids from the input to the producing well is shown in Figs. 4 to 7, inclusively, for the displacement factor considered, namely, 3:1.

The phenomenon as presented can be summarized as a performance curve for

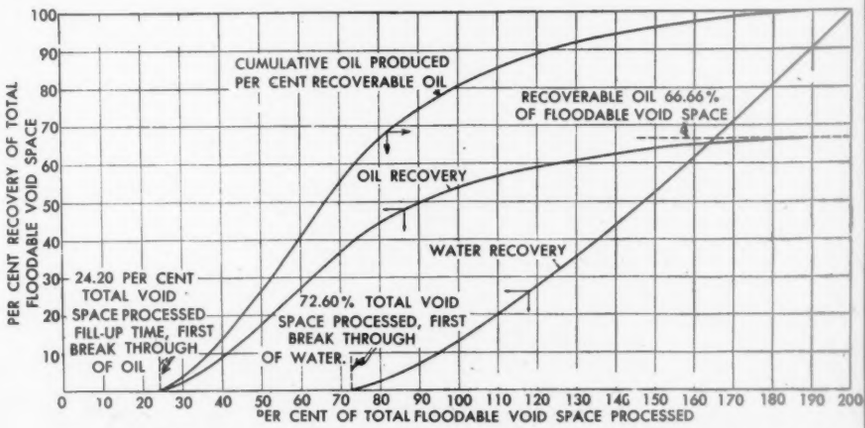

FIG. 8. Displacement factor 3:1, performance curve for five-spot water flood.

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ny displacement factor to determine he times for break through of the gas-il and oil-water interfaces, and also to stablish the cumulative oil produced as per cent of recoverable oil for any tage of the flood program.

The basis for the analysis is the total water injected, expressed as a per cent of all the floodable void space in the square pattern of the five-spot spacing nd referred to as the per cent of total loodable void space processed. For the problem at hand this corresponds to the mount of water injected that is required to displace 30 per cent of the pore space for the recoverable oil, and 15 per cent for the vented gas, or a otal of 45 per cent for a unit volume of void space. The oil produced, and water recovered, are likewise expressed as the per cent of the total floodable void space n the five-spot spacing. The performance curve computed for the displacement factor 3:1 is illustrated in Fig. 8, nd its values are listed in Table 1.

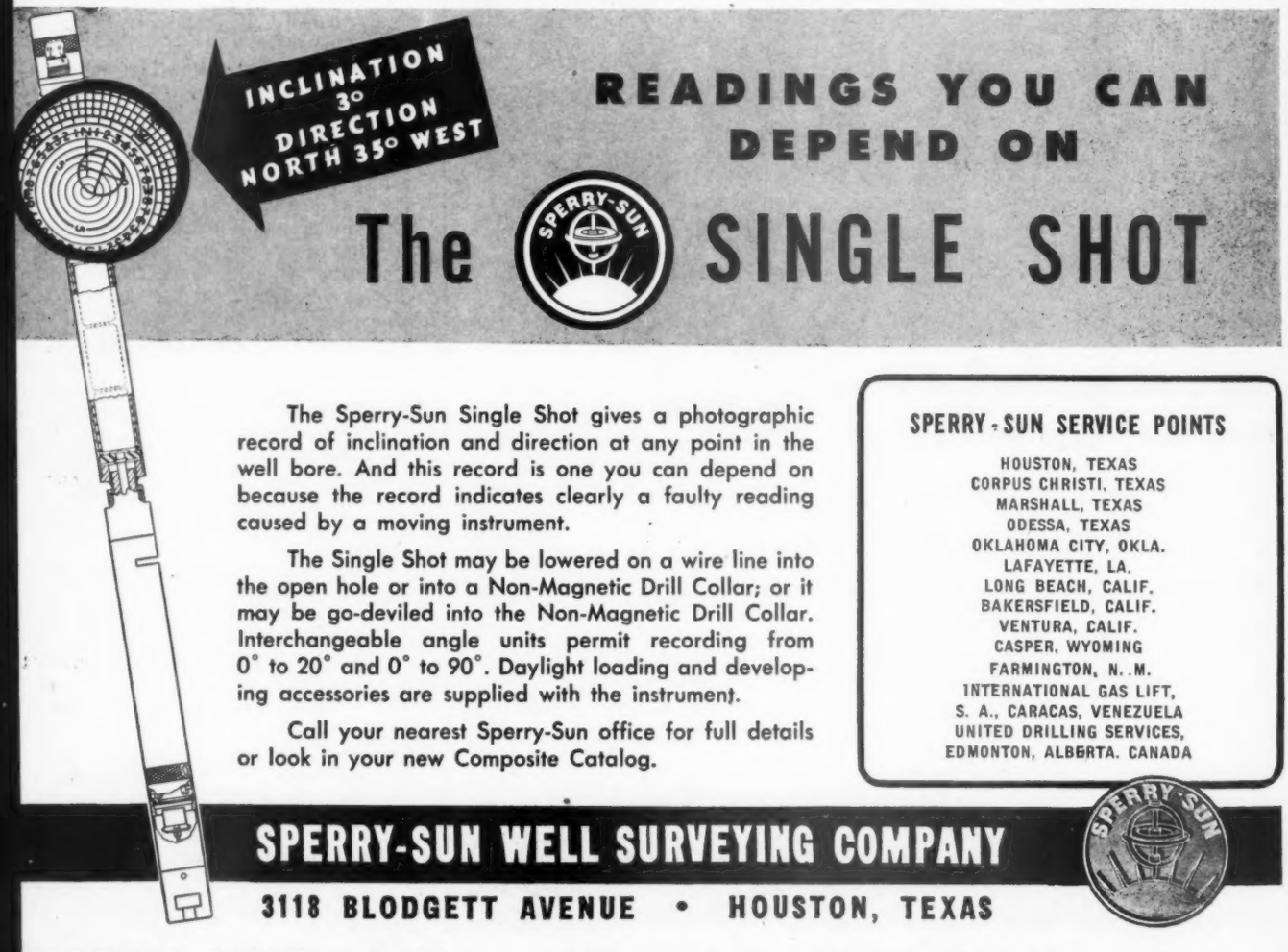
To develop the performance of the water flood, the generalized curve shown n Fig. 3 for the five-spot water flood an be employed for the advancement of he oil front, indicated by Items 1 and 2. As Item 1 refers to the total fluid processed, which equals the gas displaced by the sweep of the oil front and he production of oil and water into the well at later periods, and Item 2 is the sweep of the oil front only, then the difference, or Item 3, is the oil and water produced when break through occurs.

TABLE 1. Performance curve for five-spot water flood displacement factor 3:1.

(1) Per cent total area processed by oil seal	(2) Per cent Total area swept by oil seal	(3) Total fluids prod. by oil seal front, per cent of void space	(4) Total fluids prod. by oil seal front, per cent total floodable void space	(5) Volume of injected water processed, per cent total floodable void space	(6) Water prod., per cent total floodable void space	(7) Oil prod., per cent total floodable void space	(8) Cuml. oil prod., per cent total recoverable in formation
.90	0.89	0	0	0.30	0	0	0
3.22	3.31	0	0	1.07	0	0	0
6.45	6.60	0	0	2.15	0	0	0
12.90	13.04	0	0	4.30	0	0	0
22.57	22.45	0	0	7.52	0	0	0
32.24	32.34	0	0	10.75	0	0	0
41.91	42.11	0	0	13.97	0	0	0
51.58	51.80	0	0	17.19	0	0	0
64.48	64.14	0	0	21.49	0	0	0
72.60	72.17	0	0	24.20	0	0	0
77.37	76.11	1.26	0.42	25.79	0	0.42	0.63
83.82	79.68	4.14	1.38	27.94	0	1.38	2.07
90.27	83.13	7.14	2.38	30.09	0	2.38	3.57
103.16	88.00	15.16	5.06	34.39	0	5.06	7.59
116.06	91.92	24.14	8.05	38.69	0	8.05	12.08
128.95	94.27	34.68	11.56	42.98	0	11.56	17.34
141.85	96.24	45.61	15.20	47.28	0	15.20	22.80
161.19	98.41	62.78	20.93	53.73	0	20.93	31.40
180.00	99.40	80.60	26.87	60.00	0	26.87	40.31
195.00	99.80	95.20	31.73	65.00	0	31.73	47.60
210.00	100.00	110.00	36.67	70.00	0	36.67	55.01
217.80	100.00	117.80	39.27	72.60	0	39.27	58.91
232.00	100.00	132.00	43.99	77.37	1.26	42.73	64.10
251.46	100.00	151.46	50.49	83.82	4.14	46.35	69.53
270.81	100.00	170.81	56.94	90.27	7.14	49.80	74.70
309.48	100.00	209.48	69.83	103.16	15.16	54.67	82.01
348.18	100.00	248.18	82.73	116.06	24.14	58.59	87.89
386.85	100.00	286.85	95.62	128.95	34.68	60.94	91.41
425.55	100.00	325.55	108.51	141.85	45.61	62.90	94.35
483.57	100.00	383.57	127.86	161.19	62.78	65.08	97.62

In this respect, oil will be produced first, followed by the composite mixture of oil and water as represented by the sequence of the sweep pattern.

With reference to the advancing front, however, for the oil seal to obtain Item 3, the basis is the void space of the formation occupied by the gas and not the total floodable void space for water. As the volume of fluids produced is equal to the corresponding volume of water injected, by virtue of this displacement phenomenon, it is only a matter of interchanging the void space for the formation processed by water. In this respect the total floodable void space for water to the gas space present in the formation is the ratio of 45 to 15,



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or the displacement factor, then the fluids produced referred to the larger void space processed by water is the division of Item 3 by the displacement factor 3:1 to give Item 4, the volume of oil and water produced by the break through of the oil seal into the well, expressed as the per cent of the total floodable void space that could be occupied by injected water in the spacing pattern.

The fill-up time for the advancement of the oil front to the producing well is 72.60 per cent of the areal extent of the formation as shown in Fig. 3. As the more important aspect of the problem, however, is the amount of water injected into the reservoir to reach this stage and to establish the fill-up time for oil break through, it is necessary to convert that volume of formation occupied by the oil seal to the corresponding volume of water injected. In this respect it has been discussed that the time for advancement, or the areal extent of the formation processed, for the movement of the gas-oil interface with respect to the oil-water interface is the ratio of the displacement factor, then it follows that the volume of water injected for the incurrence of this break through is 72.60 per cent divided by the displacement factor 3:1 to give 24.20 per cent of the total floodable void space processed by water. This is general, for five-spot flood, as the volume of water required for any injection program to obtain the break through of the oil seal into the producing well is the value of 72.60 per cent divided by its corresponding displacement factor, which gives the per cent of the total floodable void space processed by the water flood.

As one is interested primarily in relating the total fluids produced by the oil break through, Item 4, with the progress of the water flood, Item 1 has also been divided by the displacement factor 3:1 to give Item 5, the per cent of the total floodable void space processed by the water injection. This value has been referred to as the abscissa in Fig. 8 in the development of the performance curve.

The work hereto performed has followed particularly the sweep of the oil front into the producing well with respect to the water injected, and it remains only to account for the advancement of the water flood itself to fit this problem into a logical sequence. Items 1 and 2, which are the data from Fig. 3, also represent the advancement of the water front, although the reference to the total floodable void space processed by the water flood is now specifically indicated by Item 5. The difference, therefore, between the total floodable void space of the formation processed by the water flood and that swept by the oil-water interface is given by Item 6, which corresponds to Item 3, and represents the volume of water produced when this second front breaks through into the producing well as identified for the formation processed by the water flood given by Item 5. As Item 4, is the production of oil and water at this time, and Item 6 is the production of water only, then Item 7, the difference between these two values, is the oil produced by the water flood, expressed as a per cent of the total floodable void space contained in the formation.

A reference to Fig. 8 will show that the cumulative oil produced for the problem treated here approaches 66.66 per cent as a limit for the total floodable void space in the flood spacing. This is all the producible oil present in the formation, as it has been stipulated in this problem that 30 per cent of the total pore space for the residual oil will be recovered by water flood and 45 per cent of the pore space will be displaced by water, which gives 66.66 per cent of the total floodable void space productive of oil. Therefore, it is quite evident that the data sustain the logic for the development of the performance curve, and that the method employed by this procedure of deductive reasoning has proved to be valid.

Finally, the oil produced given in Item 7 can be expressed as a proportional part of 66.66 per cent recovery of the floodable void space to give the cumulative oil production as a per cent of the total recoverable oil in the formation by water flood as listed in Item 8, and plotted in Fig. 8. Thus, the use of the plot is adaptable to determine the amount of oil produced for the volume of water injected in the displacement of an oil seal ahead of a water flood.

Discussion

One problem that is of particular concern of research in water flooding is the

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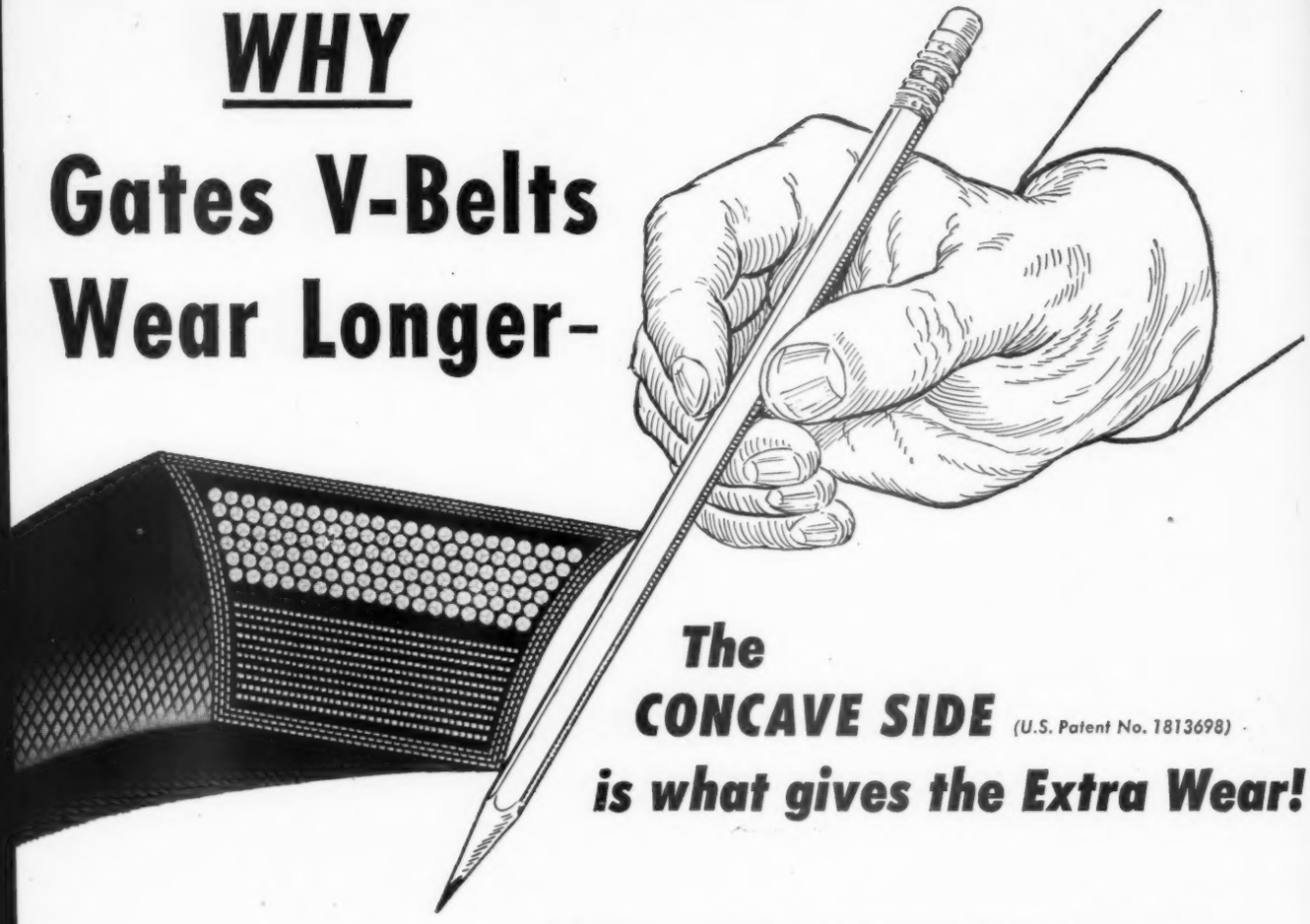

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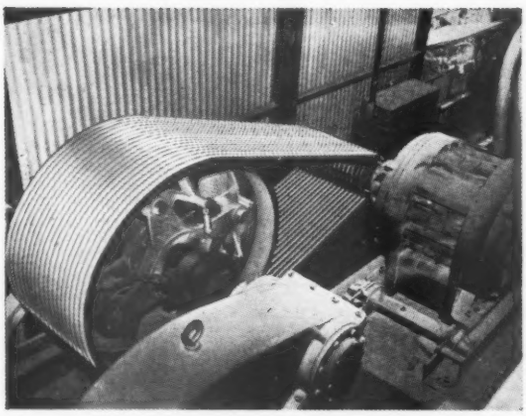

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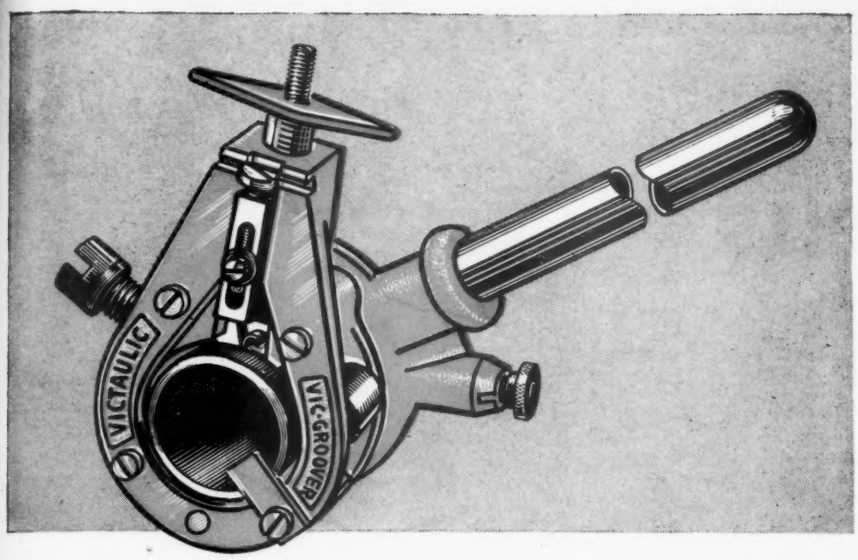

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investigation of mobility ratios on the flow pattern. Although this is a meritorious procedure, the author cannot conclude that this is the answer to the problem. The effects of the variation of mobility ratios can show a distortion in the flow pattern, but the question that can be asked is, "Can these effects invalidate the greater error that could be incurred by the enormous growth of the oil seal by the improper choice of the displacement factor?" In this respect, the problem seems to be to the contrary, as it appears that the effect of the significant growth of the oil seal can mask to a large degree whatever distortions that occur in the flow pattern. For this reason this investigator is inclined to place greater validity on recovery factors established for known reservoirs to postulate the fill-up time of oil break through to producing wells. In passing, it may be of interest for the reader to know that recovery factors for water drive have as one of its parameters, the mobility ratio that is discussed here, and it is not inconceivable that reliance on factual field data can more realistically approach field conditions to encompass phenomena that have yet to be revealed in the laboratory.

Actually, this investigator has been more concerned with the adaptability of the permeability profile that relates the relative by-passing of water flooding by parallel depositional layers, rather than the mechanics of fluid flow. Although the author has originated this concept which was first published in *The Petroleum Engineer*[4], and of which a great deal has since been written, he has been cognizant from its earliest inception that complete reliance on this interpretation can prove to be fallacious, and has been so revealed by Kavaler[5] in a recent article. For this reason the author wishes to reiterate a statement made to a technical group[3] in Fort Worth, Texas namely: "If it can be shown both for uniform sand and the application of permeability profile that cycling of formation with gas will be an economical venture, then in all probability this will be the case. If the application of the permeability profile reveals, however, that the project will not be economical, this does not condemn the property because the permeability profile as such, represents the ideal conditions for the most rapid by-passing of gas, and the project should be investigated further." In essence this applies equally to water flooding, and in effect the mechanics of fluid flow is only one facet of the all consuming problem of the understanding of lithology in the appraisement of property for water flood.

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E. N. FRISIUS†

THIS paper is a brief abstract that is intended to fill an interim need for documentation of oil well case histories. A fuller presentation of the author's address will be published in an issue of "Corrosion".

Importance of Corrosion

The dominance of corrosion as a factor in oil well operation is strikingly demonstrated in the following maintenance records of 57 representative wells from 3 major California oil fields. Corrosion control eliminated over three-quarters of all well maintenance. The remaining maintenance was due to failure of equipment, which was initially damaged before treatment was started. (See Table 1.)

Causes of Corrosive Attack

Oil well corrosion is due to the attack of acid water in an anaerobic system, for there is no oxygen in an oil well. The mechanism of attack is the simple galvanic cell which was clearly presented in the International Nickel Company's film, "Corrosion in Action". The anode reaction is

$$Fe \longrightarrow Fe^{++} + 2e$$

The cathode reaction is

$$2H^+ + 2e \longrightarrow H_2$$

The overall reaction then is

$$Fe + 2H^+ \longrightarrow Fe^{++} + H_2$$

The three common sources of the hydrogen ions are the presence of carbon dioxide, hydrogen sulfide, and fatty acids that produce hydrogen ions as follows:

$$CO_2 + H_2O \longrightarrow H^+ + HCO_3^-$$

$$H_2S \longrightarrow H^+ + HS^-$$

$$RC(=O)-OH \longrightarrow H^+ + [RC(=O)O]^-$$

G. H. Rohrback[1] and D. M. McCloud[2] have conclusively demonstrated the extreme corrosivity of an oxygen-free system consisting entirely of an iron coupon and a stream of sodium chloride solution saturated with carbon dioxide. Their method and apparatus were fully described in a recent issue of "Corrosion." They have also pioneered in explaining the phenomenon of "flow corrosion" which makes "worm tracks" on sucker rods and in well tubing. They have demonstrated that when cathodes are exposed to the scrubbing action of fluid flow, they become increasingly cathodic and thus accelerate the destruction of anodes in nearby quiescent locations.

Approaches to the Problem

The use of corrosion-resistant alloys has met with partial success, notably in stainless pumps and pump fittings. This approach, however, is expensive and is not a full solution. The use of superior alloys often accelerates the galvanic destruction of nearby less-noble metals. For instance, tubing may be destroyed by use of monel sucker rods. Plastic coatings have met with some success when carefully applied. They are vulnerable to mechanical damage and to holidays in the initial coating; and they have rigid temperature limitations. As reported by the TP-IA Committee, the use of "gadgets" has resulted in nearly uniform failure. This is because most of the gadgets have been developed from incorrect theories of corrosion or from no theory at all.

TABLE 1. Combined maintenance record of 57 wells.

Item	Year's record before treatment	Year's record during W-41 treatment	Savings due to corrosion control, per cent
Number of pumps replaced	278	139	50
Number of joints of tubing replaced	2481	387	84
Number of rods replaced	2451	425	83
Number of rod boxes replaced	2582	691	76
Number of well pulling jobs	901	282	69
Number of well crew hours	6482	1990	70

Dollar Savings With Inhibitor

Having considered the mechanism of oil well corrosion and some of the obstacles in overcoming it, let us look at a case that offers encouragement. Table 2 documents the cost experience of the Huntington State Company in combating corrosion in "slant-hole" wells drilled to tap oil, which lies beneath the sea. In such slant holes the sucker rods and rod boxes rub constantly along the lower side of the tubing. Wear and corrosion mutually stimulate each other. By use of a suitable, film-forming corrosion inhibitor, however, both wear and corrosion are controlled. The film not only stops corrosion, but it also takes the rubbing and the wear. The film perhaps wears thin, but it is repaired and thickened by fresh inhibitor, which is introduced into the well annulus in daily batches six days per week. I wish to express my personal gratitude to the Huntington State Company for authorizing the presentation of the data listed in Table 2. The cost figures show that the Huntington State Company has achieved drastic reductions of well pulling and of material replacement although the wells are still being operated with the partially corroded tubing, rods, and boxes that were in service prior to use of a liquid corrosion inhibitor.[3]

Types of Corrosion Inhibitors

Of course, the members of the NACE are familiar with the several types of inhibitors. Straight neutralizers like sodium hydroxide have been used, but the large amount of hydrogen ion available in oil wells makes neutralization impracticable except in certain low volume condensate wells. The true inhibitors function by forming films at the metal surface, and it is significant to classify the film formers by the manner in which the films form and by the location and properties of the films. Films are formed either

[3]Magna W-41.

TABLE 2. Cost experience of the Huntington State Company in the use of Magna W-41 to control corrosion in slant-hole oil wells producing from the Jones sand, off-shore from Huntington Beach, California.

	Cost of pulling wells and replacing subsurface equipment Dollars per calendar quarter				
		During treatment with Magna W-41			
Well number	Prior to treatment	4th quarter 1951	1st quarter 1952	2nd quarter 1952	3rd quarter 19
State 12	$1744	0	$1424	$ 5	0
State 14	2324	0	1128	0	0
State 16	1870	0	1475	0	0
State 18	1248	0	759	0	0
State 19	1020	0	1071	1624	0
State 20	2000	$1317	0	285	0
State 8	840		0	0	0
State 10	121		0	0	0
State 15	775		0	0	0
State 24A	346		0	0	0
State 11	386				0
Total cost of treated wells		$1317	$5857	$1914	0
Gross savings		7889	5431	9374	$11,674
Number of wells treated	0 wells	6 wells	10 wells	10 wells	11 wells
Gross savings per well		$1330	$ 543	$ 937	$1061
Treatment cost per well		55	55	55	55
Net savings per well		$1275	488	882	1006

*Abstract of address presented to the National Association of Corrosion Engineers — Western Regional Division Conference, Los Angeles, California, November 20 and 21, 1952.

†Magna Products, Inc.
[1]With the California Research Corporation.
[2]Formerly with the California Research Corporation, now with Magna Products, Inc.

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TABLE 3. Maintenance records on 20 oil wells in one Los Angeles Basin field. Comparison records for year periods before and during treatment with Magna W-41.

Well	Number of breakdowns		Tubing replaced		Rods replaced		Boxes replaced		Pumps replaced	
	Before W-41 treatment	During W-41 treatment	Before W-41 treatment	During W-41 treatment	Before W-41 treatment	During W-41 treatment	Before W-41 treatment	During W-41 treatment	Before W-41 treatment	During W-41 treatment
A	18	1	148	0	38	0	36	1	11	1
B	19	3	87	1	51	0	67	12	13	3
C	25	14	64	1	188	14	131	6	5	2
D	24	2	77	14	175	42	32	10	7	3
E	20	1	87	0	79	0	39	0	8	1
F	22	8	93	0	110	5	314	39	10	8
G	33	10	47	0	137	35	98	164	12	7
H	31	6	106	1	119	8	85	10	6	4
I	18	10	122	27	90	0	25	24	9	5
J	21	8	73	27	90	2	130	0	11	5
K	13	2	63	14	29	0	52	16	5	2
L	11	1	46	0	9	8	8	6	7	1
M	17	5	62	0	5	1	87	10	5	4
N	30	6	32	1	79	0	75	13	9	5
O	9	4	42	1	20	2	10	5	6	2
P	7	3	38	17	3	1	27	0	5	1
Q	15	2	13	0	52	0	45	15	6	2
R	15	4	53	2	37	2	63	5	7	4
S	18	6	29	2	17	4	184	56	9	3
T	30	10	77	0	32	16	30	12	7	4
Total	396	106	1359	108	1360	140	1538	404	158	67
Reduction	73 per cent		92 per cent		89 per cent		74 per cent		58 per cent	

er by adsorption to the metal or by chemical reaction at or near the metal surface.

The adsorbed films cover both the anodic and the cathodic parts of the metal surface, and adsorbed films are generally much thicker than the reactive films. There are physically adsorbed films, which generally have poor persistency and are readily scoured off the metal surface by the stream of well fluid. The most widely sold organic inhibitor is of this type.

There are also chemi-adsorbed films, which are much more tightly held to the metal surface and which are not readily rubbed off by abrasive sand or by the moving contacts between rod boxes and tubing. A chemi-adsorbed film former[4] which is being received with favor, especially where appreciable concentrations of hydrogen sulfide gas preclude the use of arsenicals.

The reactive film formers may be classified as anodic or cathodic types. Anodic types, of which the chromates are an example, react at the anodes and coat the anodes. The disadvantage of anodic inhibitors is that they may cause destructive pitting by coating, say, 99 per cent of the anodes and thereby causing the remaining 1 per cent to corrode "like mad." The cathodic type inhibitors coat the cathodes selectively and thereby interrupt the function of the galvanic cell. There is no danger of pitting due to the use of a cathodic-type inhibitor because even a partial covering of the cathodes will immediately slow down the rate of metal loss at each and every anode.[5]

Material and Labor Savings

Table 3 presents the detailed material replacement and well-pulling records for 20 individual wells. The table shows the maintenance data for a period of 1 year before the wells were treated. For direct comparison for each well and for each maintenance item, corresponding data are presented for a period of 1 year during which the wells were treated with Magna W-41, cathodic-type inhibitor.

[4]Magnahib.

[5]Magna W-41, is an example of a widely used inhibitor that reacts at the cathodes of the metal surface to form a tightly persistent film of molecular dimensions.

Essentials of Control

Now we have seen that uncontrolled oil well corrosion is an expensive proposition and that materials and techniques are available to control oil well corrosion.

How is the corrosion engineer to proceed? In order to obtain results like those demonstrated in the wells reported in the preceding tables, he must study each individual well. He needs iron counts and perhaps corrosion coupon tests before any inhibitor is used. He needs to keep informed on changes in the well's production, particularly on its rate of water production. Dosages need to be adjusted to fit varying well conditions. Any increase in iron count of well effluent should be investigated immediately. Determination of the concentration of inhibitor residuals in the well's effluent is a very useful tool in studying a particular well or a new treating method. The most frequent cause of failure of a well to respond to treatment is failure of inhibitor to reach the well fluid.

The selection of the best method depends both upon the characteristics of the individual well and upon the properties of the inhibitor to be used. The essential element in a successful corrosion control program is continuity of engineering attention.

Additional Benefits

Lower well maintenance cost is only the most obvious benefit of oil well corrosion control. Increased and sustained production is another very valuable benefit. Benefits extend beyond the well itself, however. Inhibitor residuals present in the well's effluent carry on the benefits to protect flow lines, traps, gage tanks, wash tank bottoms, and even waste water disposal lines, and injection wells. The increasing recognition of these many benefits is resulting in rapidly expanding use of inhibitors to control oil well corrosions. * * *

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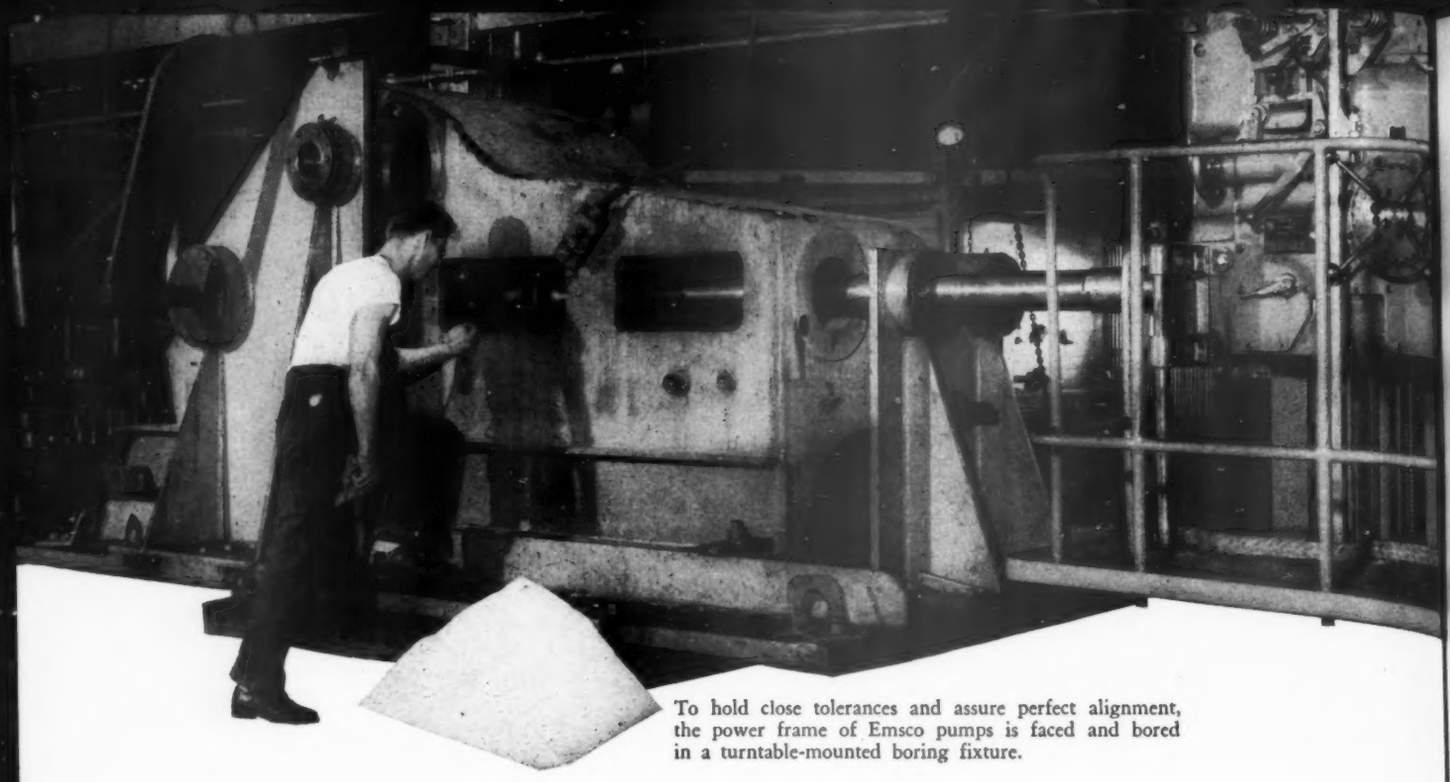

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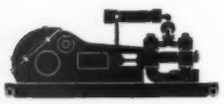

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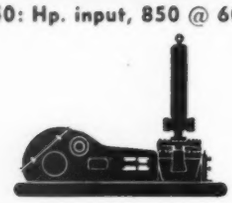
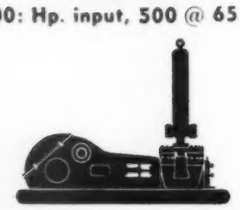
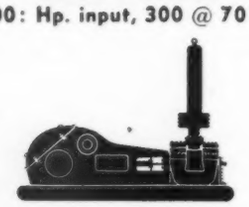


D-500: Hp. input, 500 @ 65 rpm.



D-300: Hp. input, 300 @ 70 rpm.



D-175: Hp. input, 175 @ 75 rpm.

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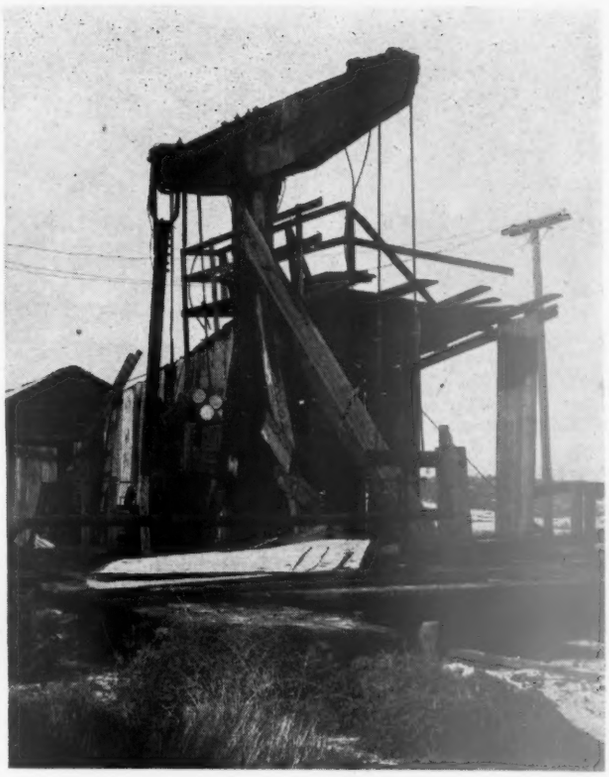
Standard 86-ft wooden derrick, typical of those destroyed by Shell Oil Company in the Midway-Sunset field.



Temporary expediency was to throw the derrick and leave the well floor and belt house as they had been before.

EXCLUSIVE

Changing Oilfield Scene

Modernization in Shell's California field operations brings safety and greater efficiency by the removal of the old wooden derricks

WILLIAM T. RINTOUL

ONE of the landmarks of the early day petroleum industry is gradually disappearing from the American oil scene. Wooden derricks, best known of all oil field installations, are being torn down to make way for modernization — and greater safety — in the fields where pioneer drillers brought in this country's first producing wells.

Passing of the wooden derrick with its gaunt, oil-blackened frame and air of rough-hewn sturdiness is of some historic interest. It all began more than 25 years ago when operators decided that they wanted to go a little bit deeper than they had gone before in their search for new oil. The weight and vibration of the powerful rotaries they developed proved too much for the wooden derricks.

Steel seemed to be the answer. Steel

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Modernized wells with the new look. Bob Phelan, Shell engineer, right, stands beside well recently modernized on Gore lease.

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rigs could handle the new rotary equipment. Steel proved to be more economical; it could withstand weather and corrosion much better than wood. Steel derricks proved more efficient; they could be moved from location to location and used to drill more than the one well for which they were originally erected. Almost overnight steel derricks replaced the stationary wooden derrick in the American oil fields. Wooden derricks remained as the outmoded markers of the nation's older fields.

Today in many of the older fields the wooden derrick has passed from the stage of being picturesque to the point of being a safety hazard.

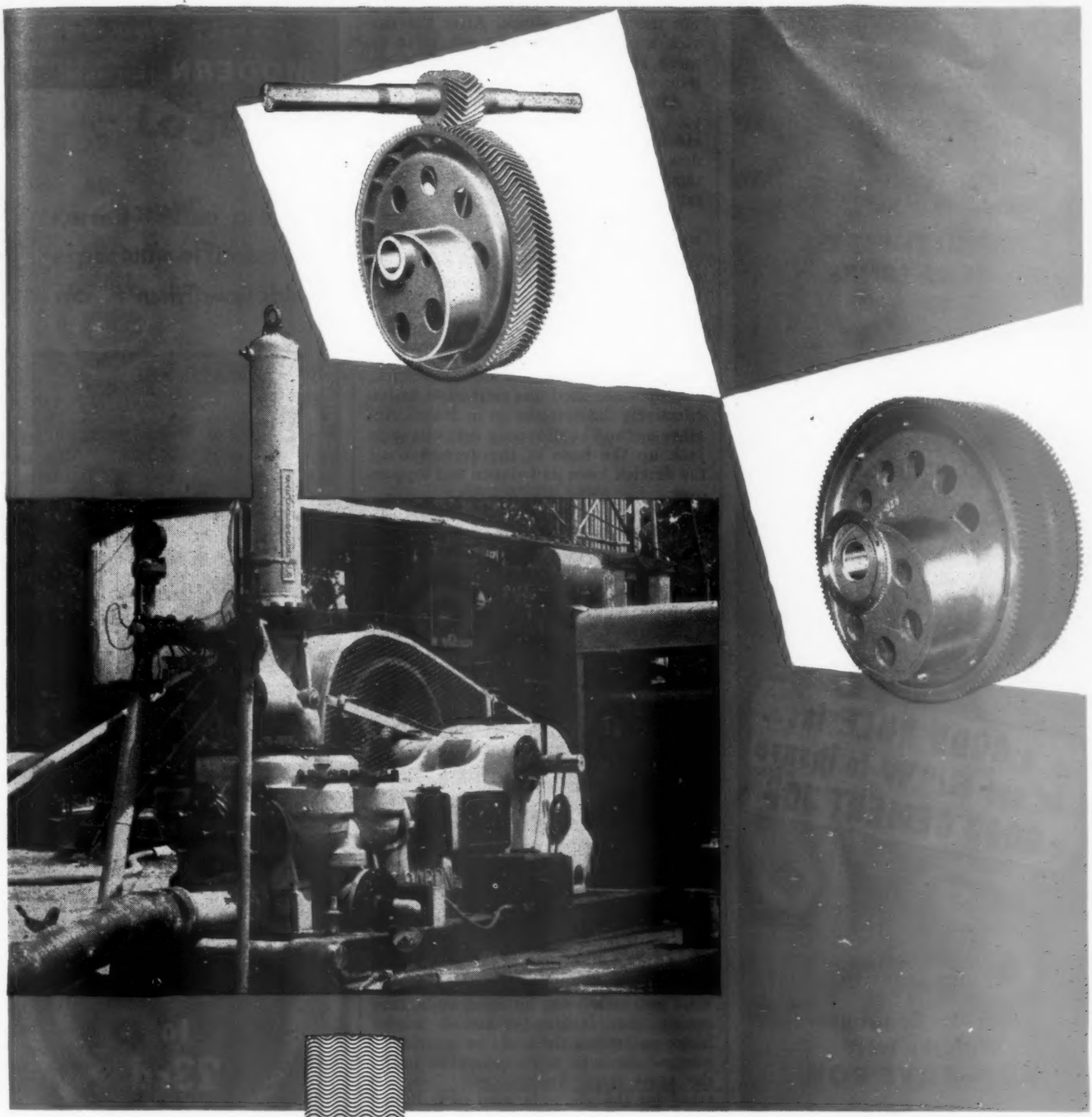
As a result, many operators have hastened the decline of the wooden derrick by tearing out the weathered masts to replace them with safer, more modern installation.

Typical of such modernization projects is a program carried on by Shell Oil Company on the Gore and Western leases near the town of Fellows, California, in the 52-year-old Midway-Sunset field. Shell Oil Company purchased the leases from Petrolia Corporation in 1949. There were 30 producing wells on the leases then. Most of them had been drilled in 1926; all were relatively shallow, averaging about 1000 ft in depth, and all produced 11.5 deg API gravity crude oil at an average rate of 6 bbl per day.

When the new operator took over, standard wooden derricks 84 ft high still stood over the old wells. The derricks were in a bad condition. Wind had torn the pine boards loose many times, and repair crews had repeatedly nailed them back to the frame. The ends were chewed away with nail holes, and the wood was full of termites. Obviously well-pulling crews could not be sent into work over the wells under such conditions. And repairing the derricks loomed as too costly an operation to justify the results.

As it became necessary to pull the wells or take other remedial action to keep them on production, the new operator found that work over jobs meant much more than simply dispatching a well-pulling crew to the lease for a routine days' work.

Pulling a well meant first throwing the wooden derrick. Loss of time entailed in dropping the derrick and disposing of the termite-ridden wood was



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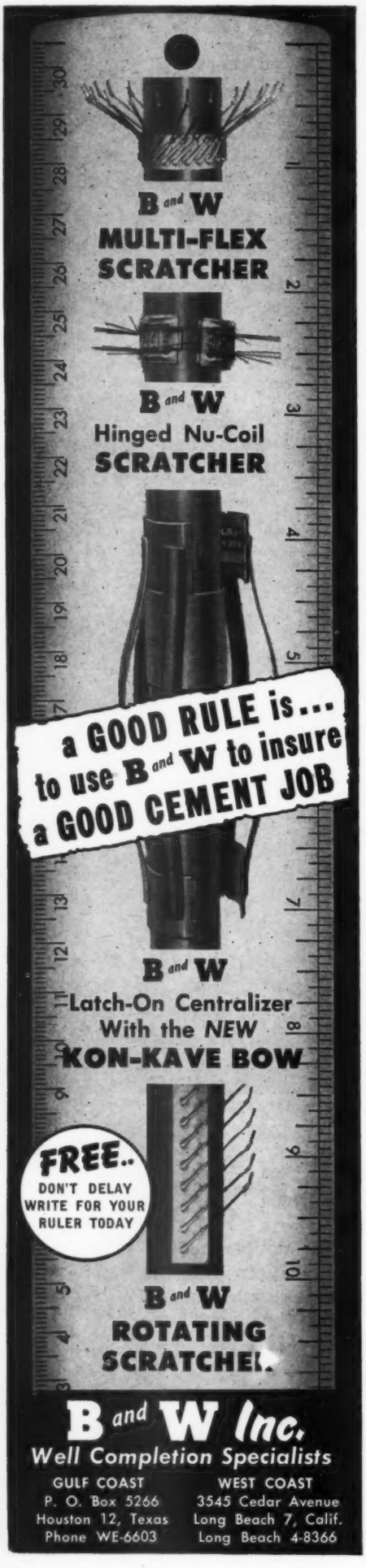


not the only drawback. After the derrick was down, it was necessary to cement in anchors for the portable gin pole used in the actual pulling job.

After handling the first few pulling jobs in this fashion, the operator decided on a definite program for tearing down the old derricks and replacing them with modern installations to facilitate future work over jobs.

First phase of the program, of course, was destruction of the wooden derricks. Simplest of the methods used to throw a derrick — and the method used to topple the 24 derricks that were still standing on the Gore and Western leases — is to attach a cable to the top of the derrick, connect the cable to a winch truck, and move the truck away from the derrick. The operator used this method to flatten effectively the derricks on its leases. Another method of dropping derricks is to jack up the base of the derrick until the derrick loses its balance and topples over.

Disposal of wood from the derricks was next on the program. The pine boards were in such bad shape that they had no salvage value whatsoever, so the operator simply dragged them away from the wells and burned them. Wood from the belt houses and floors was also burned.

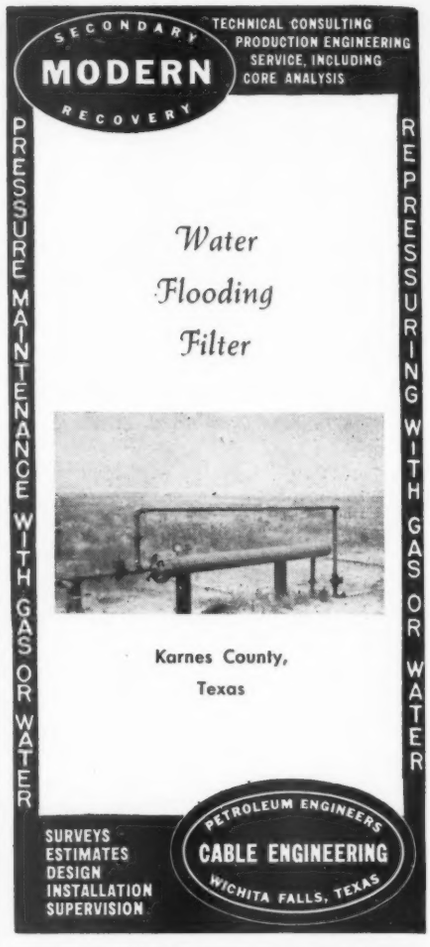
After the derricks had been destroyed, the operator took care of the most expensive phase of the modernization program: Replacing the old installations with the new — mats, anchors, and in some cases new pump units and motors.

Concrete mats were poured around the well heads — a 10-ft by 7-ft mat for the pulling unit and a smaller 4-ft by 6-ft mat for the pump unit. In some cases the two mats were poured at right angles to each other, with the well head at the junction point. In other cases, the mat for the unit was poured in line with the mat for the pulling unit. It was decided to keep several wells on production on a jack line, but pump unit mats were poured anyway for these wells, reasoning that future production might hinge on putting the wells on individual pumps. Anchors were concreted in at the same time. Anchors were necessitated for the gin pole used to pull the wells.

Modernization work was directed by W. Cortwright, construction foreman for Shell Oil Company's San Joaquin Valley division, with headquarters in Bakersfield, California.

Modernization of the Gore and Western leases destroyed the last real concentration of wooden derricks on a Shell Oil Company lease in the San Joaquin Valley. Only a few scattered derricks remain on the company's leases.

While many an old-timer undoubtedly would not recognize the Midway-Sunset field today without its forest of wooden derricks, most oil men are agreed that the field has a cleaner look — and there is no doubt that safety conditions have been improved considerably for the men who work the wells. It is a far cry from the old days of "steel men and wooden derricks." The steel men are still around, but the wooden derricks are rapidly disappearing. * * *



Application of Radiation Logs in Oil Fields

Porosity often presents an operational problem, especially in limestone formations. A logging device is now available that indicates porous zones

PAUL CHARRIN AND J. H. RUSSELL

HEREWITH is a very brief and general outline of the way radiation logging is practiced in the field. As there are various methods used, we will limit our brief description to the most modern technique, the simultaneous logging of natural gamma rays, the neutron-neutron log, and the collar log.

The entire subsurface instrument is nine feet long, with an outside diameter of 3⅝ in. Fig. 2 shows the general relation of the various parts of the subsurface instrument, namely, the neutron source, the neutron counter, the pulse transmitter, which transmits signals from the subsurface to the surface, the gamma ray detector, and the collar locator.

The subsurface instrument is connected to a single electrical conductor which is the insulated core of an armored steel cable. This single conductor is used to transmit the power from the surface down to the subsurface instrument and to send up all the signals from the subsurface instrument to the recording instruments.

Generally, at the surface, two automotive units are used. One is especially equipped with a winch to lower and raise the cable, and a second unit, electrically connected to the first one, contains all the recording instruments. For shallow and medium depths, however, there are some combined units where the winch and recording instruments are all mounted on the same vehicle.

Both radioactivity and neutron logs are automatically plotted by a recorder with two pens traveling across a well log paper, which is moving vertically in synchronism with the depth of the subsurface instrument. The pens move to the right when radiation increases.

Logs are generally recorded at a scale of 5 in. for 100 ft, but they can also be recorded at scales of 2 and 1 in. per 100 ft.

Until 1950 radioactivity and neutron logs were plotted without any zero and the results were therefore entirely relative, but since 1950 radioactive logs have been plotted in micro-roentgen per hour. Also, very great progress has been made for a quantitative scale of neutron logs. The record indicates neutron counts per second. The zero point is therefore known at all times.

Radiation Logs

A few years ago, when gamma ray logs and neutron logs were made separately, they were generally used for different purposes, but now, with the advent of simultaneous logging, in most cases the two logs are available, and a much better interpretation and use are made of the combination of the two, plus the collar locator. Therefore, the following paragraphs will deal generally with combined logs where both gamma ray and neutron logs are used to reach better conclusions.

Application in Wells Previously Completed. As indicated at the beginning, the outstanding quality of radiation logging is the fact that it can be used in wells that have already been cased. It is the only logging method that can be used under those conditions. Therefore, the most obvious use of radiation logs, and the one at which the pioneers of radiation logging were aiming, is the study of oil wells in the old fields where information is scarce or even non-existent, especially in the fields that had been drilled up before the advent of electrical logging. It is true that radiation logging cannot distinguish between oil and water, but it gives a good lithologic definition of the formations.

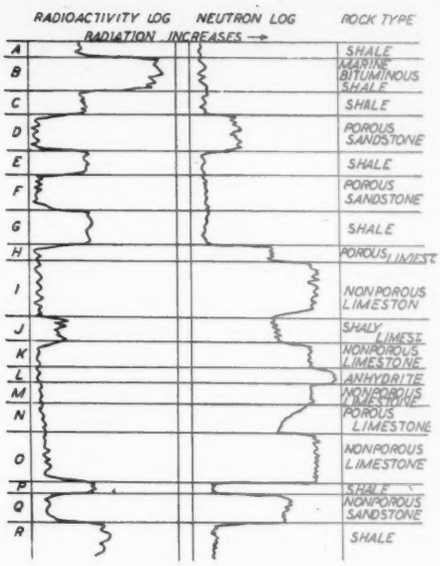


FIG. 1. Idealized radiation log.
(By W. L. Russell)

Workover of Old Wells. In many cases it has been discovered in the late life of an oil field that some producing horizons had been passed during the early stages of drilling. It was known, either by earlier sample logs or by correlation with more recent wells, that a producing oil sand was somewhere behind the casing, and, in fact, in many cases the approximate depth of such a producing horizon can be estimated, but not with too much precision. This is where radiation logging comes as an ideal instrument to determine exactly where the production is and, therefore, to make it possible to recomplete the well.

Fig. 3 shows the example of an old well in the East Texas field. The well had been completed without the help of electrical logging and relying only on the driller's log. The gamma ray log

The Authors

Paul Charrin

James H. Russell

Paul Charrin is president of Perforating Guns Atlas Corporation. He organized Atlas Well Service Company in 1947 and when it merged with Perforating Guns Company in 1949 under the present name he became president. A graduate of the University of Paris, Charrin came to Texas shortly after graduation in 1925. From 1930 to 1934 he supervised the development of electrical logging in its first industrial application on a large scale in Soviet Russia. From 1934 to 1936 he was in charge of all foreign exploration for Schlumberger, and in 1936 became vice president and manager of Schlumberger Well Surveying Corporation, until he resigned in 1945.

James H. Russell is director of the radiation well-logging department of Perforating Guns Atlas Corporation. A graduate of A & I College, he spent two years with the research department of Shell Petroleum Corporation, developing geophysical apparatus to be used in oil prospecting. He is a registered professional engineer in Texas and belongs to several engineering societies and the American Petroleum Institute.

†Abstract of paper presented at the 19th International Geological Congress, Algiers, September, 1952.

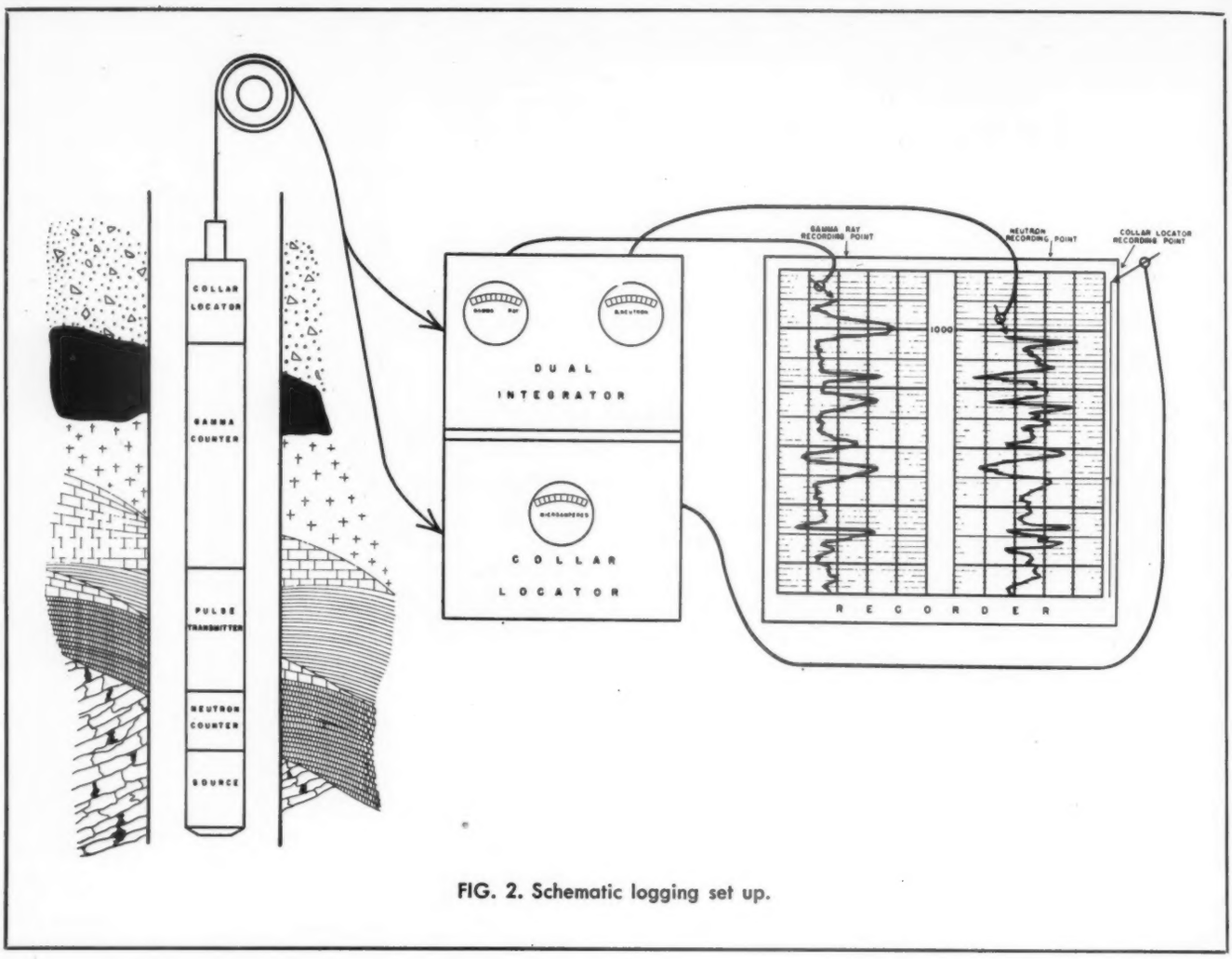


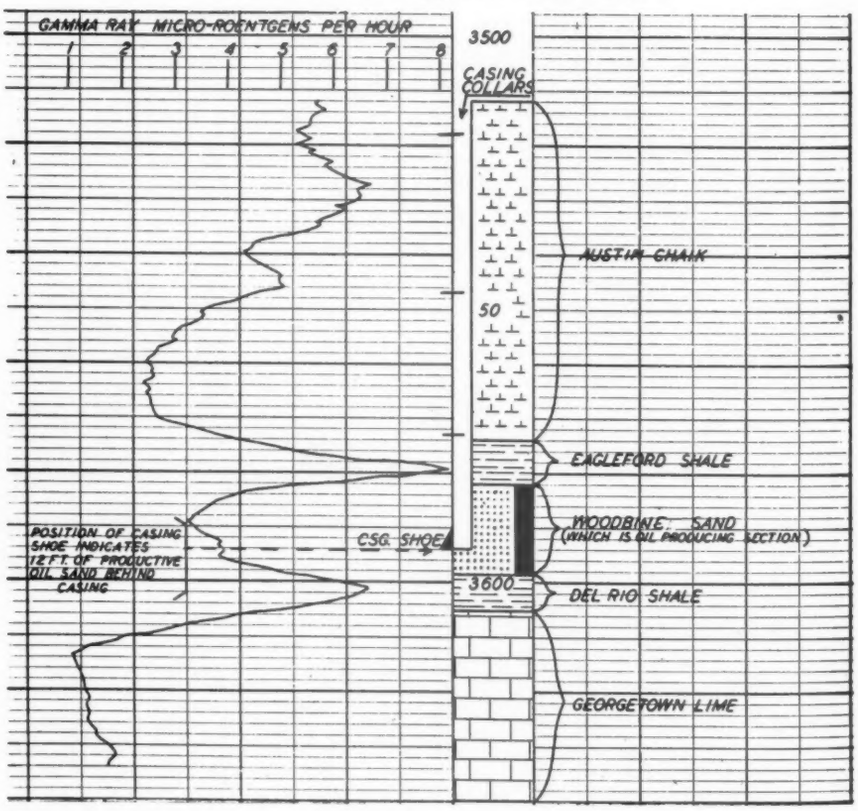
FIG. 2. Schematic logging set up.

shows very clearly that 12 ft of the Woodbine producing sand have been cased at 3594 ft. This means that the well can be recompleted from 3582 to 3594 for increased production. It can be seen that the log gives a remarkably clear definition of the different formations, and more especially of the Eagleford shale that is immediately on top of the Woodbine sand, and the Del Rio shale immediately under.

If radiation logging were limited to the study and working over of old fields, its field of application would be very limited. In fact it would tend to disappear because during the last 20 years electrical logging has brought out more and more information, and the case of holes drilled without complete logging information is not very frequent. Even now, however, there are many cases where the information is not obtained at the time of drilling and where radiation logging has to be called to the rescue.

Recompletion of Wells. An outstanding example of such a case happened in the very recent development of the so-called Spraberry sand in the Permian Basin of West Texas. An entirely new area of tremendous proportions was opened by this new discovery. In the area quite a number of old wells had drilled through that formation without recognizing at the time its production possibilities. The problem, therefore,

FIG. 3. East Texas recompletion of an old well.



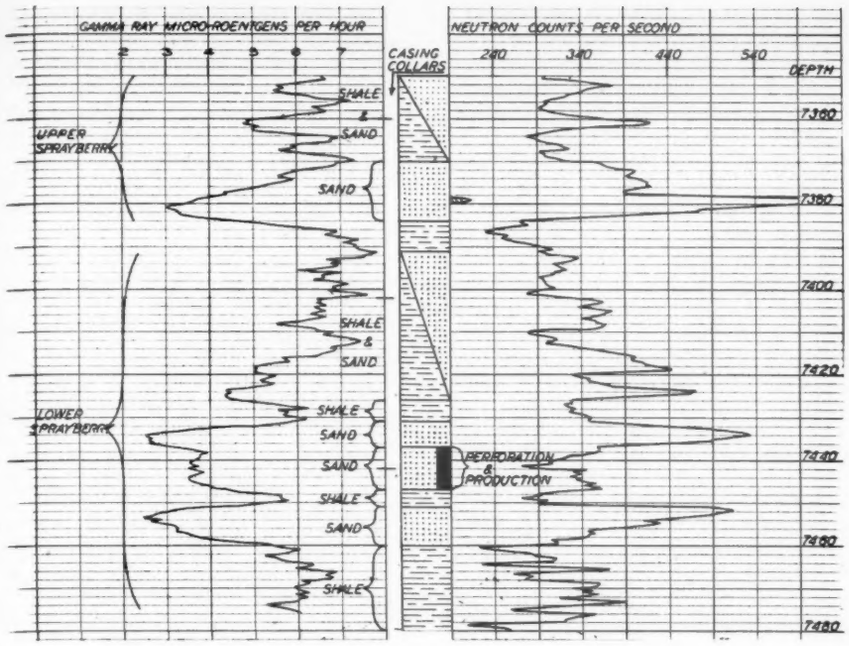


FIG. 4. Spraberry in West Texas — Discovery of production passed up in deeper drilling.

was to locate the formation behind the pipe of the wells already drilled.

Fig. 4 shows such an example. This well was originally drilled and produced below 10,000 ft in the Ellenburger limestone formation. Although electrical logs were run at the time of drilling, there was no evidence either from the electrical log or the driller's log, that a producing zone was present at a shallower depth. Subsequent discovery of oil production from the Lower Spraberry formation led to the running of a simultaneous radiation log in this well.

The log gives a good definition of what is called the Upper and Lower Spraberry sections, which are a complex of shales and sands. The well was completed in a sand of the Lower Spraberry section, which the neutron log shows very clearly as fluid bearing. The well is now one of the best producers of the Spraberry trend, about 3000 ft above the original production.

Another case where radiation logging is the only tool available is the one where for one reason or another casing has to be set before a complete log of the open hole has been made. This may happen, and in fact does happen when, for instance, the well is in danger of a blowout and casing has to be set immediately. In such a case it is very valuable to be able to obtain a log of the part that has been cased.

Applications in New Wells. The above examples are typical ones where radiation logging comes as the only answer to a difficult problem. If the use of radiation logging, however, was limited to these problems, it would not have enjoyed the tremendous development of the last 10 years. The main reason for this development is that even when good information is obtained during the drilling, either by sampling or mechanical coring, or by electrical logging, radiation logging comes as a very useful auxiliary tool. It brings extra information that would not be available otherwise, and more than anything, in combination with the collar log, it is an outstanding, even indispensable technique to complete oil wells at the proper level. This is especially true in the case of deep wells and in the case of thin horizons.

Control of the Depth of Completion. One of the main difficulties in logging oil wells has always been to tie together all the available information in relation with depth. Every successive process results in some type of information connected with depth, but, unfortunately, the depths are measured by different means, and practically always show some discrepancies, sometimes very large. A very serious, not to say vital problem confronts the operator who wants to complete the well in a certain formation, recorded at different depths by different methods. Since the appearance of the collar log, this problem has been satisfactorily solved in the following way.

The collar log is recorded simultaneously with both the gamma ray and neutron log in the modern technique. The radiation log can practically always be correlated very satisfactorily with the electrical log, or the sample log. As the casing joints, or collars, are tied up to the radiation log, now correlated with the other available information, those collars, or casing joints, can be used as permanent bench marks for any subsequent operation in the oil well. More especially, when it is attempted to put the well into production, it is a simple procedure to locate one or more casing joints within, or in the vicinity of the formation to be produced, and from there to perforate the casing at the proper depth.

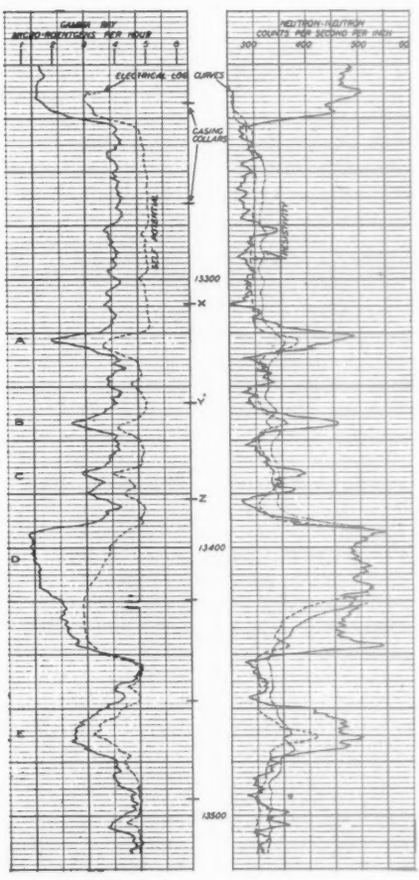
Fig. 5 is a good example of how the radiation log can be correlated with the electrical log. On the left section the gamma ray log correlates perfectly with the self-potential log. On the right section the neutron log correlates very well with the normal resistivity curves. In fact, the electrical log and the radioactivity log can be superimposed to the foot, and the casing collars recorded with the radiation log are automatically attached to it.

We shall not go into detail of the interpretation of the log, but it is obvious that the sands marked "A," "B," "C," "D," and "E," show excellent prospects of production, and, therefore, will have to be tested at one time or another. On a sand like "D," which is about 50 ft thick, even at a depth of 13,400 ft, a discrepancy of a few feet in the various measurements might not be too serious. To produce a sand like "B," which is only 6 ft thick, at 13,350 ft, a small error of one-thousandth in measurements might very well result in testing the wrong zone. On the contrary, when all the logs and the collars are tied together, it is a very easy matter to check the collars with the gun perforator, such as "X," "Y," "Z," and starting from collar "Y" shoot from 4 to 10 ft below.

The type of information described above is so important that it is now common practice to make a radiation log of practically all wells below 6000 or 7000 ft.

Determination of Gas/Oil Contacts. Radiation logging also brings information that would not be available otherwise. This is the case of oil and gas con-

FIG. 5. Correlation of electrical and radiation logs.



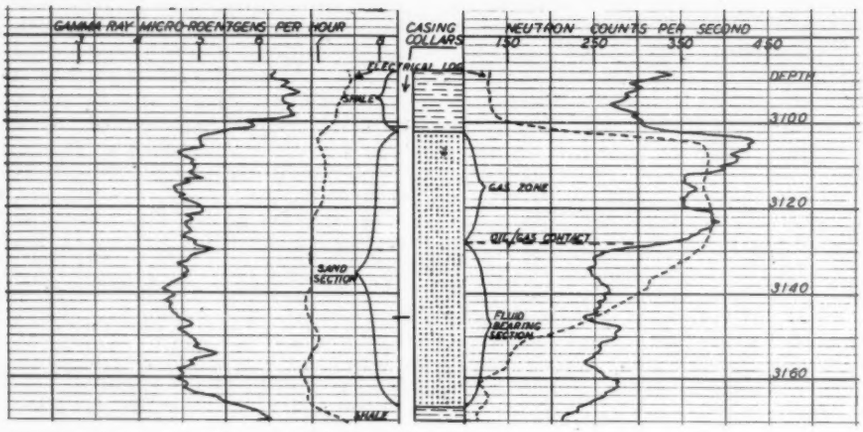


FIG. 6. Example of oil/gas contact in sand body.

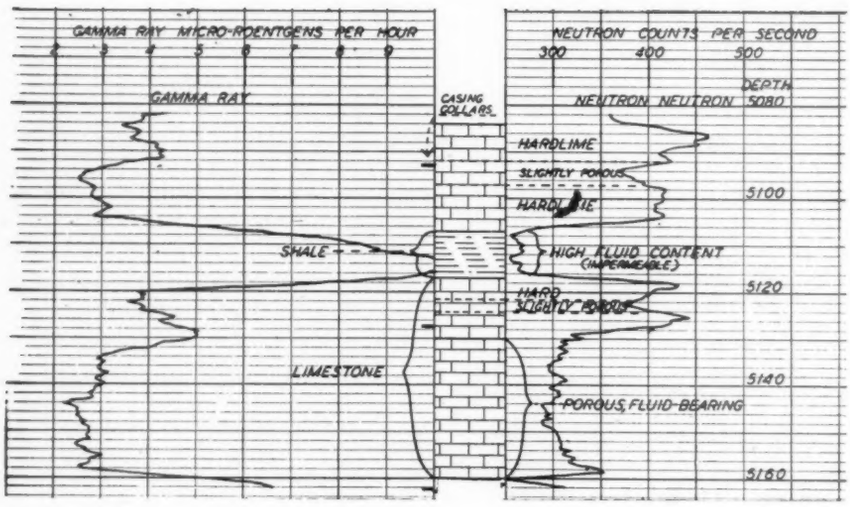


FIG. 7. Defining porous section in limestone.

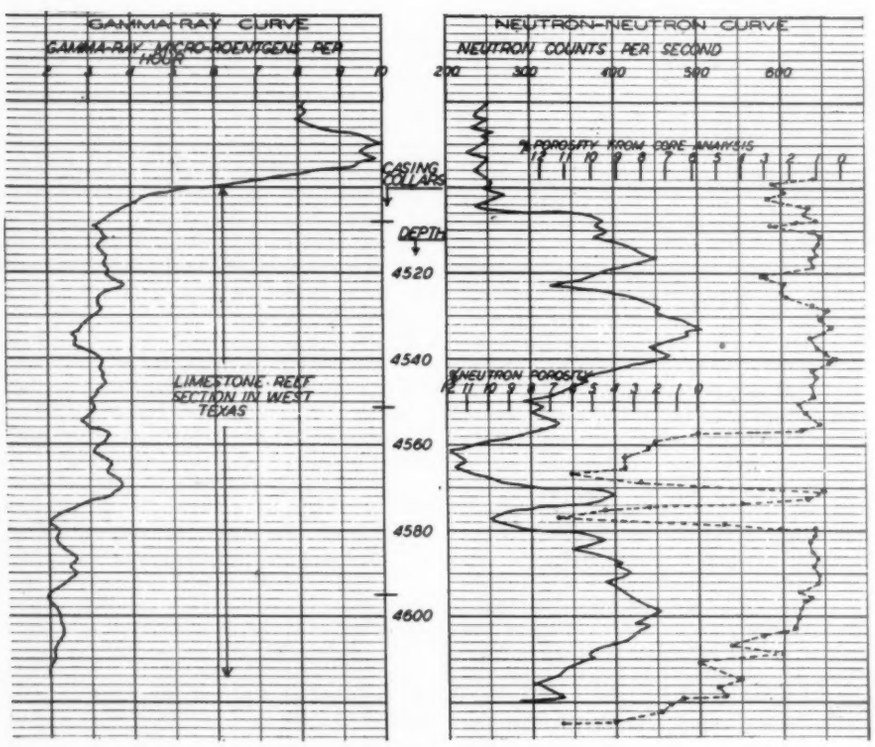


FIG. 8. Quantitative determination of porosity.

tacts. On account of the distribution of hydrogen in both oil and water, present radiation logging cannot easily define an oil/water contact. Sometimes, however, it does. On the contrary, due to the fact that natural gas, except possibly at very high pressures, contains fewer hydrogen atoms per volume than oil or water, it is often possible to find on radiation logs very clear fluid/gas contacts.

Fig. 6 is a typical example of such determination. The electrical log shows the water level at 3100, but does not define the oil/gas contact. The neutron curve shows a definite break at 3128, which corresponds to the gas/oil contact. Of course, such determination is possible only if the formation has relatively uniform porosity in the vicinity of the contact to be determined. Otherwise, the variations of porosity could mask entirely the variation due to the gas/oil contact. The ability of the neutron curve to define such oil/gas contacts has proved very important in well completions.

In oil fields that have been producing for years, this curve has proved to be a valuable aid in re-locating gas/oil contacts that have moved from their original location due to the amount of oil produced from the reservoir. In some fields it has been proved from a study of a series of neutron logs, run periodically during the producing life of a well, that the gas/oil contacts moved up the hole in proportion to the depletion of the new reservoir.

Determination of Porous Zones. A very important application, especially in limestones, is the determination of porosity. This information is obtained either in the cased hole or in the open hole.

The neutron log is primarily influenced by the presence of hydrogen and, therefore, by the presence of fluid in the formations. This property has made neutron logging a very important method for determining fluid bearing or porous zones in hard formations, and especially in limestones. This application of radiation logging is particularly important, because the problem of finding zones susceptible of production in the limestones has never been solved satisfactorily. The electrical log, which generally gives a fairly complete answer as to the favorable zones in a complex of sands and shales, is not a very reliable method in hard formations. In spite of the recent developments, such as contact logging, the situation has not changed very substantially. On the contrary, it seems more and more certain that radiation logging can and will give a reliable answer, at least to the extent of defining in limestone the zones that are porous. Here again, the radiation log will not give any indication as to the content of the formation, that might be either oil or water, but at least it can indicate the zones that are fluid bearing.

Fig. 7 is a typical example of how a combination of gamma ray and neutron logs can be interpreted to define porous fluid bearing zones. This example shows how the two logs are necessary for such a determination. The neutron log alone, as already said, could not distinguish

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between an impervious shale having a high fluid content and a porous fluid bearing limestone, but the gamma ray log, which shows the shales very clearly, makes it possible to distinguish between the shaly and the porous zones. The combination of the two logs makes the interpretation possible. The logs show shale from 5106 to 5117, a hard limestone from 5117 to 5130, and a porous limestone from 5130 to 5160, the maximum porosity being around 5145.

Quantitative Evaluation of Porosity. During the last two or three years a further step has been taken, and from the qualitative determination of porous zones, radiation logging has progressed to the quantitative evaluation of porosity, at least under favorable conditions. This information has been obtained in the past by use of diamond bit coring and making a complete analysis of the section. This method is very effective, but very costly and time-consuming.

The first attempts at quantitative evaluation of porosity through the neutron log were made in the Permian Basin of West Texas and in Western Canada. In both cases it was the matter of porosity in hard formations, such as limestones, dolomites, and reef materials. It has to be remembered, however, that at present the method or methods used are still empirical. There is no known way yet to translate immediately the information derived from the neutron log in terms of true porosity, but by comparing actual results of core analysis in a given well with neutron determinations, it is possible to calibrate the neutron curve, and from there, to extend this calibration to some other wells in the same formation. In spite of its limitations, the advantage of such a method is obvious because in an ideal case it would eliminate entirely the tremendous cost of coring the formations for the purpose of core analysis and, in less favorable cases, reduce that cost in a very large way by coring only one control well out of, let us say, 4, 5, or 10 wells in the same general area. It has to be remembered all the time that the calibration of a neutron curve is valid only for one geological formation and only in a limited area, which, however, might cover a whole field. The neutron calibration cannot be extended to another geological formation and very seldom can be extended to the same formation in another field.

There are several ways to approach the calibration of the neutron curve, and some very interesting papers have been published on the subject during the last two years. In taking the non-porous zones of a hard formation it is generally possible to determine on the right side of the neutron log a good line of "zero" or minimum porosity. On the left side, a line of maximum fluid is also determined, generally corresponding to a shale, and it is generally possible to interpolate between the maximum and minimum valuations. In the most favorable cases, as, for instance, in the Redwater field in Canada, quantitative values determined by the neutron log would agree within 1 per cent or less with the core analysis results.

The quantitative analysis of the neutron log has very definite promise, but it is necessary always to keep in mind its limitations.

First, there are some instrumental limitations in that precise determinations of porosity require the recording of the neutron log to be made under identical conditions, or at least under conditions that can be correlated one with another numerically. In this line, the progress made toward absolute measurements of neutrons is very important.

The second point is that a new set of determinations has to be made for each hole diameter. Also, the determinations for one string of casing would not be valid through two strings of casing. It is to be noted in this respect that the most accurate determination cited above in the Redwater Field of Alberta were made under very uniform conditions: holes of the same diameter, same mud, same program of casing.

Another limitation that existed in the older neutron-gamma method is the fact that in addition to the gamma rays of capture that are being measured, there is a variable background of gamma rays originated by the source. This spurious factor was not very serious in wells of relatively small and uniform bore hole diameter, but it becomes quite serious in wells of larger or non-uniform diameter. Also, in some cases a strong

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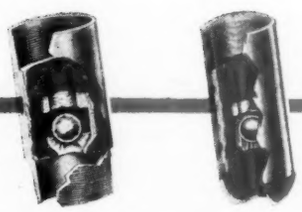

At left are shown the Larkin Regular Float Shoe (Fig. 302) and the Larkin M&F Float Collar (Fig. 401 M&F).

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natural gamma radiation of the formation could introduce a very substantial error. Fortunately, with the advent of the neutron-neutron, or pure neutron log, these detrimental factors have been entirely eliminated.

Fig. 8 shows a good example of the comparison of porosity determined by core analysis and porosity determined by the neutron-neutron curve. Generally speaking, there is a remarkable correspondence between the two determinations. In comparing core determinations and neutron determinations, it has to be kept in mind that they cannot be identical because they do not measure exactly the same thing. Measurement of a core porosity is a strictly local determination. On the contrary, the neutron log averages the porosity over an interval from one to two feet and, therefore, it has been found that the comparison between the core determinations and neutron determinations is much improved when the core data are averaged over intervals of one to two feet.

Evaluation and Trends of Radiation Logging

The present paper certainly does not pretend to cover the whole field of radiation logging, and it is only a very general outline of what can be expected at present from the use of radiation logging in the oil fields. At least two problems should be mentioned where radiation logging is extensively used. One is the exploration for uranium, the other is the determination of potash beds in salt masses. In both cases the gamma ray log shows strong radiation.

From the little that has been said on the theory of radiation logging, it is obvious that the problem of interpretation is very complex. Many factors affect the log. We talked about lithological factors, but we did not go into other factors like the diameter of the hole, the presence or absence of casing in the well, the presence or absence of fluid in the well, the annular space between the instruments and the bore hole and the connected problems of shielding, the distance between the neutron source and the detector. All these factors have to be taken into consideration, and are the object of detailed studies both in theory and by experimentation.

Hydrogen has a preponderant effect on the neutron logs, but undoubtedly other elements in the rocks also have an influence that at present has not yet been clearly evaluated.

Compared with electrical logging, radiation logging is about 10 years younger and is still in its early stages. Therefore, there is hope of very important new developments in the next few years.

The progress achieved during the last two years is very encouraging. The introduction of the neutron-neutron, or pure neutron log is of primary importance, because in geophysics one cannot hope to analyze correctly a measurement which is a mixture of several factors.

The importance of simultaneous radiation logging also cannot be overemphasized, because as long as the only technique was the time-consuming method of running one log after another, it was impossible to gather enough information for important progress. This has been changed now, and there is no reason why a third, and possibly a fourth log could not be made simultaneously exactly as in the case of electrical logging, therefore, bringing up new and important information.

Acknowledgments

We wish to thank Perforating Guns Atlas Corporation and its personnel, who have authorized and made the preparation of this paper possible.

We also want to thank Professor W. L. Russell, of the geological department of Texas A & M College, for his contributions to this paper, and Serge A. Scherbatskoy for his very valuable suggestions and criticism. * * *

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Helmerich and Payne rig 35 that drilled the Fender D-3 well to 10,000 ft in the record breaking time of 30½ days in the Elk City field, Oklahoma.

Drilling Contractor Can Increase Efficiency

Many factors influence field operations and personnel should be considered in order to obtain a successful organization

A SPLENDID record of efficient and speedy drilling in the Elk City field, Oklahoma, has been set by Helmerich and Payne, Inc. The factor of personnel relations warrants special comment in the drilling improvements that predicate this operational achievement.

The normal drilling time for a 10,000-ft well in the Elk City field has been 42 days. Three years ago in this area it was not uncommon for that depth to be reached in as many as 65 days. In January, 1953, a field record was made when the Fender D-3 well was drilled to a depth of 10,000 ft in 30½ days. The rig emloyed was an Oil Well 96 powered by 3 Waukesha 6-LRO engines, and the auxiliary equipment included double hydromatic brake, automatic driller, and 2 slush pumps an Oil Well 8 by 20 and a 7¼ by 18. The previous record was 32½ days with a National 80 rig that was equipped with torque converters, dynamatic brake, an automatic driller, and 3 Waukesha 6-LRO engines.

Over the past 3 years various improvements have reduced drilling time in the area. In an analysis of the better and faster drilling results it was found that technological and physical factors were prominent. The equipment, weight, drilling bits, and rotary speeds are items that influence field performance. It must be realized that good equipment is essential. It is felt that the drilling time records could not have been obtained without the proper equipment and tools.

Many other phases of the successful operation must be recognized. Without complete and efficient cooperation of the company's fleet of trucks and their drivers and truck pushers, the crew of mechanics in the district yards, and the administrative help in these offices it would be impossible to maintain an efficient organization, or equal, or surpass any field records. Credit must also be given to the spendid cooperation the company has received from the field personnel of Shell Oil Company. Their efficiency has always been beneficial to our operations. In a word, drilling crews can only do their work efficiently when backed up by efficient co-workers.

With the basic understanding that good equipment is essential, one then turns to the most intangible and unpredictable factor in the drilling industry, that is, the personnel employed.

Too many times the drilling contractor discounts or does not give adequate consideration to the tremendous importance that the man on the rig and the man behind the rig, the tool pusher, has on its operation. The head office staff of the company feel this personnel factor is the key to a successful operation, because without capable employees the best machinery on earth will not dig oil wells efficiently.

For many years Helmerich and Payne, Inc., has had close personal contact with its men in the field. Two of the district superintendents, J. H. Carmichael and E. L. Eppinger, have been with the company for more than 25 years; Herb Benge has been with the company for 20 years, and T. C. Coleman has been with H&P for 15 years. Throughout the organization there are 23 other men with more than 15 years with H&P. Until recently W. H. Helmerich, president, personally visited each rig at least once a year. Now, that the company has diversified and expanded it is no longer possible for him to make such frequent trips to the field. The policy, however, of close head office contact with the field has been maintained through frequent visits of other key executives. Herman Aweas, drilling superintendent for the company and associated with H&P for 19 years, makes constant flying trips to all areas in which company rigs are operating. Dee Sikes, special liasion executive and representative, also makes frequent tours with other company executives who are contracting H&P equipment. Walt Helmerich, III, vice president and assistant to the president, takes every opportunity to visit field operations.

The personal contact has been maintained even though the company has grown tremendously in size over the past years. Although personal contact and

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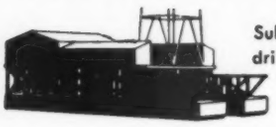

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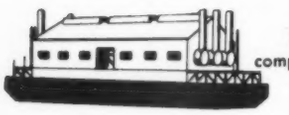

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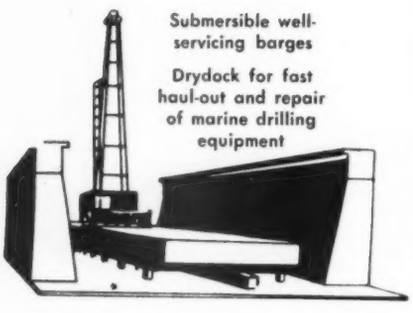

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association provides increased efficiency and more efficient communication it cannot be, and should not be, the sole answer to loyal employees.

Recognizing this, the company was one of the first independents to sponsor a pension program. It extends to all field personnel and has been in effect since October 1, 1943. Cost of the pension plan is paid completely by the company. Benefits for hourly employees is the factor 58.24 times hourly dollar earnings at the time of retirement, in other words a driller earning $2.36 an hour would receive a monthly pension for life upon retirement of $137.45. Monthly employees receive a monthly retirement of 24 per cent times their monthly salary.

This pension program has been very successful in reducing turn-over of personnel and in insuring men who spend their life with the company an adequate pension at retirement. The company feels that a man who has spent his working lifetime with a company should be compensated for his diligence and loyalty upon reaching the retirement age.

Two years ago the company purchased over a thousand acres adjoining the proposed Lake Wagoner. During the last two years the heavily wooded hillsides were cleared and a large lodge and seventeen cabins were constructed. A spacious boathouse has been built, boats provided, many recreational features are available, and the lodge itself offers entertainment for some three hundred guests.

Recently the company put in effect a safety award program, which after certain time intervals awards gift certificates to drilling crews without lost time accidents. If a crew completes 365 working days without loss of time due to an accident all crew members are presented with an expensive wrist watch, in addition to the gift certificates they have obtained during the year. This program has resulted in making drilling crews more safety conscious, in developing closer cooperation among crews, and in increasing competition between crews to reduce accidents.

Through this personal contact and the various formal personnel programs the company has attained a loyal and efficient organization in the oil fields. The loyalty factor is one which cannot be entered on the financial statement, it cannot be charted, and it is impossible to purchase. Of all the tools management has in its hands the opportunity to utilize the loyalty of its employees is the most valuable.

If the men in the field feel that the company they are working for is their company, that their efforts are recognized and may be rewarded, that the chance for advancement depends on their ability, and that they will be dealt with fairly, one has the organization with which to set drilling records and then to better them. * * *

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Current Drilling Practices in West Texas†

Permian Basin operations are slow and expensive efforts are made to reduce costs to increase rates of penetration

DAVID JOHNSTON* and W. R. JOHNSTON‡

THE Permian Basin of West Texas and Southeastern New Mexico has been one of the most active drilling areas in the United States for several years. On January 1, 1947, there were 2950 rotary rigs in use in the United States, about 350 of which were actively operating in the Permian Basin. Six years later, at the end of 1952, the number of active rigs in the United States had decreased to 2628. Active rigs in the Permian Basin, however, had increased almost 43 per cent to 496. This concentration of drilling activity is to be expected in an area that produces about the same amount of oil daily as is produced in the states of Oklahoma, Louisiana, Mississippi, and Arkansas.

Because drilling in the Permian Basin is slow and expensive and because so many rigs are operating in the area, there has been much interest in advances in drilling practices that tend to increase drilling rates and decrease rig operating costs. Interchange of ideas and information between operators is widespread through such mediums as an active API Committee on Drilling Practice. Thus, drilling techniques that prove economically sound spread rapidly throughout the area. The purpose of this paper is to review practices now in general use in the area, and to discuss techniques and equipment not in area-wide use but which appear to offer promise in increased drilling rates in the Permian Basin.

Weight on Bit. In 1947 some of the early results of high weight-drilling were discussed at the spring meeting of the Southwestern District, API Division of Production.[1] It was pointed out at that time that maximum bit weights seldom exceeded 5000 lb per inch of bit diameter. This weight limit is still generally observed, with the possible exception of larger-sized bits, because experience has been that higher weights lead to premature bit failure; and also because there has apparently been no economical increase in penetration rate with higher bit weights. It was noted at the same time that the use of high bit weights had brought about several problems. Among these were: (1) use and care of long drill-collar strings; (2) fishing for drill collars and cones; and (3) an increased tendency toward hole deviation with high bit weights. The first two problems, use of long collar strings and fishing for drill collars, turned out to be closely related. Several interrelated ideas and procedures have developed that have materially reduced the incidence of drill-collar failure, and thus reduced the fishing hazard. Most important has been the routine inspection of drill collars, primarily by magnetic-particle inspection, for cracks in threads to eliminate bad joints prior to failure in the hole. It is difficult to estimate the number of fishing jobs that have been prevented by drill-collar inspection, but certainly each operator can recall several instances of discovery of incipient failure on the rack before failure occurred in the hole. In addition to inspection, in the past four or five years there has been more widespread interest in the development and use of properly balanced drill-collar box and pin sizes and in the stress relieving of drill-collar connections. It is probable that this latter design feature has been of more significance in increasing drill-collar connection life than have changes in thread design or work hardening of thread roots, both of which have received much comment in recent years. In any event, all of these procedures have tended to reduce the chances of a drill-collar fishing job.

Should a drill-collar fishing job occur, the development of very satisfactory "free point" indicators and the use of the string-shot technique in connection with the indicators has made fishing for long drill-collar strings much less hazardous.

Although no figures have been assembled on loss of bit cones, it is believed that slower rotary speeds, on the order of 60 rpm or less, have reduced loss of bit cones. Development of special cone baskets, the use of heavy mills to break up cones, and the development of magnetic fishing tools have all tended to reduce the fishing hazard.

FIG. 1.

Hole deviation is still very much of a problem and is discussed in more detail later herein.

Developments in Bits

During the past two to three years two types of rock bits have become important in West Texas, viz., the jet rock bit using high nozzle fluid velocities, and the "chert bit" with sintered tungsten carbide inserts. Although neither bit is suitable for use on all rigs in all situations, both have been used with sufficient success to merit discussion.

Jet Rock Bits. Initial experimentation with the jet-bit principle in West Texas began as early as 1938. Water courses were added to bits and/or shrouds were installed between the cones with the idea of directing the fluid to the bottom of the hole. These early experiments and some as late as 1947 indicated no noticeable improvement in bit performance and, consequently, experimentation ceased. The success of the jet drag bit and, shortly afterward, the jet rock bit in the softer formation areas led several West Texas drillers to active testing of the jet rock bit approximately 2½ years ago. Results were promising enough that during the past 20 months Humble Oil and Refining Company rigs in West Texas have been using all jet rock bits within the limitations of the supply of integral jet bits and jet rock bit subs. The availability of integral jet bits is increasing steadily. Fig. 1 and 2 illustrate two common integral jet bits.

The evaluation of jet rock bits in West Texas has been more or less puzzling. The Humble Company has had excellent

†Presented at the Spring Meeting of the Southwestern District, Division of Production, American Petroleum Institute, Hilton Hotel, Fort Worth, Texas, March 4-5-6, 1953.

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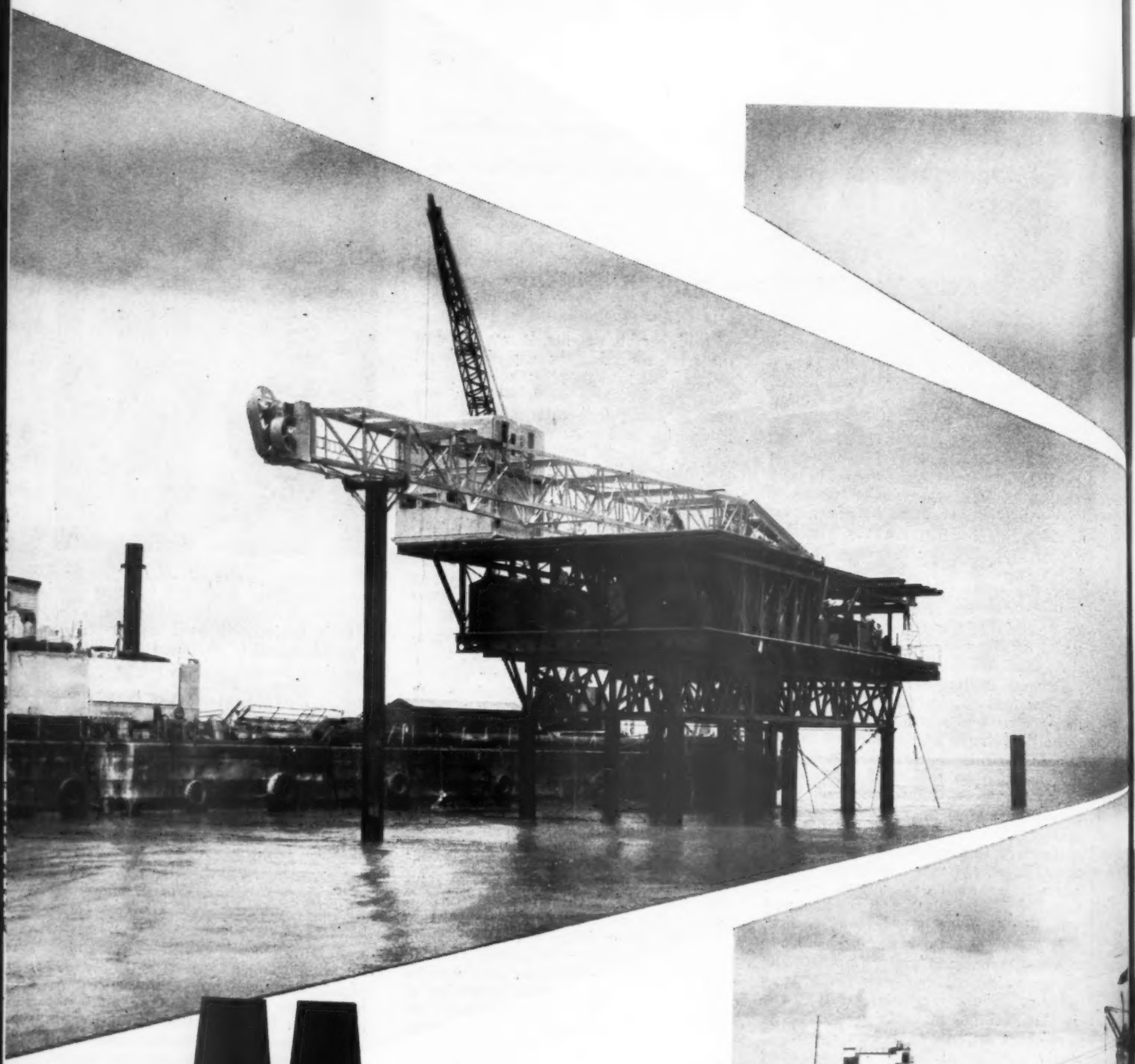

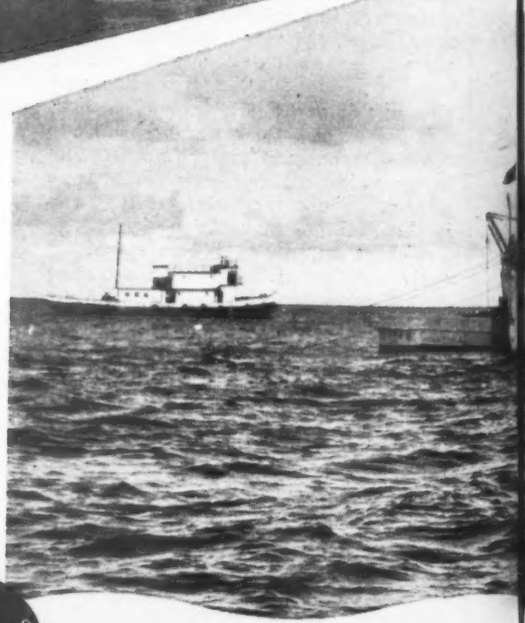

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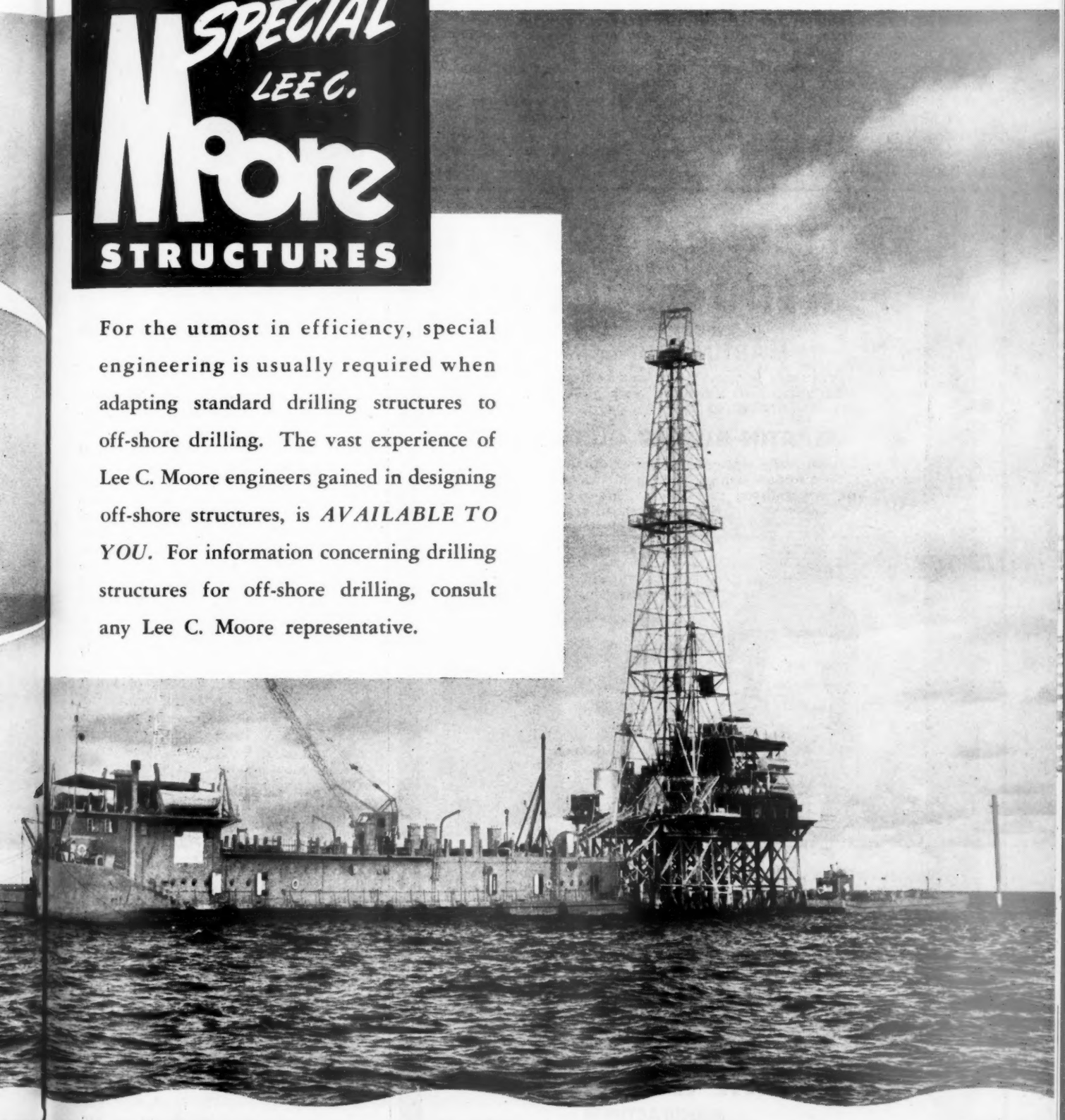

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results using jet rock bits, but they also adopted the use of oversize drill collars and slower rotary speeds at about the same time, either of which may have materially aided bit performance. In addition, their rigs are equipped with pumps capable of putting in excess of 700 hydraulic horsepower into the hole. Nevertheless, there is no question in the minds of the people operating these rigs that the jet rock bit has improved drilling rate and reduced the number of bits.

Tables 1, 2, and 3, compare the use of jet and conventional rock bits in the Yarbrough and Allen field. In the 12¼-in. and 11-in. surface holes, the use of jet rock bits has increased the rate of penetration as much as 100 per cent and reduced the number of bits required by 50 per cent. This increase in bit performance is largely attributed to the higher bit weights that are possible when using jet bits. In the 8¾-in. hole through the Permian lime section, the two jet-bit-drilled holes shown in Table 3 had a slightly slower rate of penetration, but the number of bits required was reduced by as much as 50 per cent. The overall rig time required was considerably less on the jet-bit-drilled holes, and the reduction in bits alone more than paid for the 15 to 20 per cent additional cost of the jet bits. Improvement in bit performance with the jet rock bit in the Yarbrough and Allen field has been consistently good in all hole sizes.

Other operators have met with varying success with the jet rock bit. In general, those having adequate hydraulic horsepower available for use at the bit are using jet rock bits in the softer formations and are reducing overall drilling time. Many others have tried the bits and have not shown enough improvement to convince them that the bits justified their use. There are several possible reasons why the average West Texas driller has not readily accepted the jet rock bit. In the first place, the average West Texas rig has 250 to 300 hydraulic horsepower available for fluid circulation. In a 12¼-in. hole at 3000 ft with 4½-in. drill pipe and 450 ft of 2¾-in. bore drill collars, approximately 1150 hydraulic horsepower is needed to maintain an annular velocity of 175 ft per minute and a jet nozzle velocity of 250 ft per second. There are probably no rigs in West Texas capable of delivering 1150 pump horsepower. Good jet-bit results may be obtained by reducing annular and nozzle velocity, but not to the range where 250 hydraulic horsepower will permit effective jet-bit operations in a 12¼-in. hole.

On the other hand, 250 hydraulic horsepower would be adequate in 6¾-in., 7⅞-in., and 8¾-in. holes to depths of 7500 ft or more, provided 4-in. O-D or 4½-in. O-D drill pipe is used with drill collars having a bore of 2¼-in. or larger, preferably larger.

Many West Texas operators feel that only rigs with extremely large pumps can properly use jet bits. This is not correct for the average West Texas hole program. Figs. 3 and 4 illustrate the hydraulic horsepower requirements for an 11-in.-7⅞-in. hole program, which is a common program in the area. An annualr velocity of 150 ft per min and a nozzle velocity of 225 ft per sec are assumed, and it is believed are adequate for good jet-bit results. Referring to Fig. 3, which is for an 11-in. hole using 4½-

FIG. 2.

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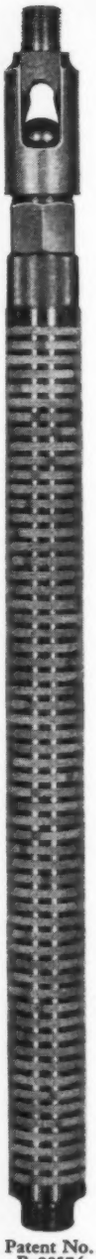

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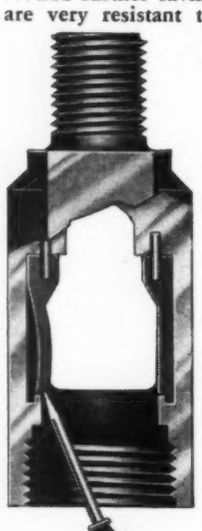

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in. extra-hole drill pipe and 300 ft of 7¾-in. O-D by 2¾-in. I-D drill collars, it is noted that approximately 290 hydraulic horsepower is needed at 1000 ft and some 50 additional hydraulic horsepower per additional 1000 ft of hole. A typical West Texas program calls for 1800 ft of 11-in. hole, which would require a maximum of 350 hydraulic horsepower. Many West Texas rigs have one pump, or two pumps capable of parallel operation, which will provide this amount of hydraulic horsepower and consequently could use jet bits.

Referring to Fig. 4, which is for a 7⅞-in. hole using 450 ft of 6-in. O-D by 2¼-in. I-D drill collars, it is noted that the hydraulic horsepower requirements are shown for three sizes of drill pipe. The total depth of an average West Texas well is around 8000 ft. Only 140 hydraulic horsepower is needed at that depth with 4½-in. extra-hole drill pipe and 205 hydraulic horsepower with 4-in. full-hole drill pipe, both of which are in the power range practically all rigs in the area. With 3½-in. IF drill pipe, the hydraulic horsepower needed jumps to 375, which is out of range of most area rigs primarily because a pump pressure of around 2000 psi would be needed.

The improvement with jet rock bits in the average small hole is difficult to recognize, primarily because the improvement comes in increased bit life. There are numerous cases where jet rock bits have been run in the Lower

TABLE 1. Jet vs. conventional rock bit performance. Yarbrough and Allen field — 12¼-in. surface hole.

Well	Y & A 31	Y & A 32	Other Operators	
Depth	185—3550	180—3547	320—3533	305—3539
Footage	3345	3367	3213	3234
Bits	7 Jet	6 Jet	6 Jet 4 Conv.	13 Conv.
Rotating hours	99¼	91	141	180¾
Feet per hour	33.7	37	22.8	17.9
Feet per bit	478	561	321	249

TABLE 2. Jet vs. conventional rock bit performance. Yarbrough and Allen field — 11-in. surface hole.

Well	Y & A 33	Other Operators		
Depth	173—3545	305—3425	306—3400	289—3563
Footage	3372	3120	3094	3283
Bits	6 Jets	7 Jets 3 Conv.	4 Jets 5 Conv.	14 Conv.
Rotating hours	91¾	114½	118¾	182½
Feet per hour	36.8	27.2	26.1	18.0
Feet per bit	562	312	344	235

TABLE 3. Jet vs. conventional rock bit performance. Yarbrough and Allen field — lime section 8¾-in. hole.

Well	Y & A 32	Y & A 25	Other Operators	
Depth	3547—7585	3555—7457	3535—7517	3539—7436
Footage	4038	3902	3982	3897
Bits	17 Jets 1 Conv.	15 Jets	24 Conv. 1 Jet	31 Conv.
Rotating hours	271½	264½	263	254½
Feet per hour	14.9	14.8	15.1	15.3
Feet per bit	224	260	159	126

TABLE 4. Jet vs. conventional rock bit performance. Yarbrough and Allen field — lime section, hours per bit — 8¾-in. hole.

Well	Y & A 32	Y & A 25	Other Operators	
Depth	3547—7585	3555—7457	3535—7517	3539—7436
Footage	4038	3902	3982	3897
Bits	17 Jets 1 Conv.	15 Jets	24 Conv. 1 Jet	31 Conv.
Rotating hours	271½	264½	263	254½
Rotating hours per bit	15.1	17.6	10.5	8.2

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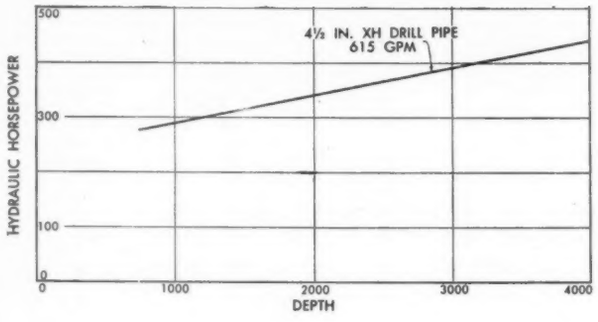


FIG. 3.

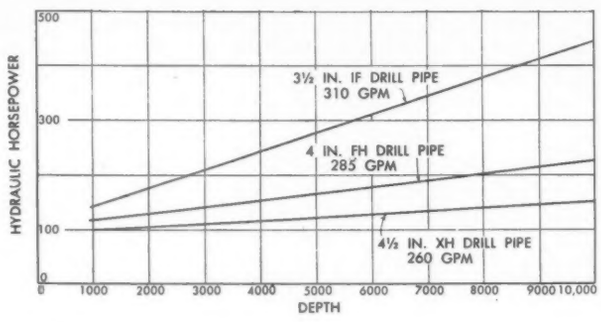


FIG. 4.

Permian and some deeper sections under maximum weights for periods as long as 20 to 25 hr. In these sections two years ago average bit life was 6 to 12 hours. It is difficult for many drillers to realize that bit performance can be improved by leaving a bit in the hole, especially when they have become accustomed to short bit life.

Table 4, which uses the same data from the Yarbrough and Allen field as did Table 3, illustrates the increase in bit life possible with jet bits. In this case the minimum increase is 50 per cent and the maximum exceeds 100 per cent. This is probably one reason why some drillers have not been satisfied with jet rock bits even though the horsepower was available. A rotary torque indicator is very helpful in determining when to pull a jet rock bit in all but the very abrasive formations. It has also been noticed that slow rotary speeds are effective with jet bits, and may be a decided factor in the bit-life increase.

Another factor that has hindered improvement with the jet bits is the widespread use of 3½-in. drill pipe and 2-in. or 2¼-in. bore drill collars. Some West Texas operators are using, and more are contemplating the use of, 4-in. O-D drill pipe that has a tool joint only slightly larger than 3½-in. drill pipe. The 4-in. drill pipe can be used safely in 6¾-in. hole and is considered safe by some operators for use inside of 7-in. casing. As shown in Fig. 4, an additional 170 pump horsepower is required for jet-bit operation at 8000 ft with 3½-in. drill pipe when compared with 4-in. drill pipe. Inasmuch as the nominal weight of 4-in. drill pipe is 14 lb, compared with 13.30 lb for 3½-in., the increase in hook load at 8000 ft would be small. Drill-collar bore can also be very critical. Assuming a rig pumping 300 gal per minute through 600 ft of 2-in. bore drill collars, 82 hydraulic horsepower would be required just to pump through the collars. If the bore were increased to 2¼-in., the hydraulic horsepower required would be reduced to 48 and with a 2½-in. bore to 28 hydraulic horsepower. The loss in weight of the collars would be only 6 lb per ft if the bore were increased from 2 in. to 2½ in.

All of the factors mentioned have contributed to the problem of evaluating the jet rock bit in West Texas. Based on Humble's experience, jet-bit performance in West Texas may be evaluated as follows:

From the surface through the red beds, salt, and anhydrite section to the San Andres formation, results have been very good with increases in penetration rate as much as 50 per cent and a reduction in the number of bits by as much as 50 per cent. From the San Andres to the Devonian, no readily apparent increase in penetration rate, but a reduction in the number of bits by as much as 50 per cent. From the Devonian through the Montoya, no conclusive data; but the drilling of this section is not as great a problem since the advent of the tungsten carbide chert bit. From the Montoya into the Ellenburger, enough increase in both bit life and penetration has been noted to justify the use of the jet rock bits.

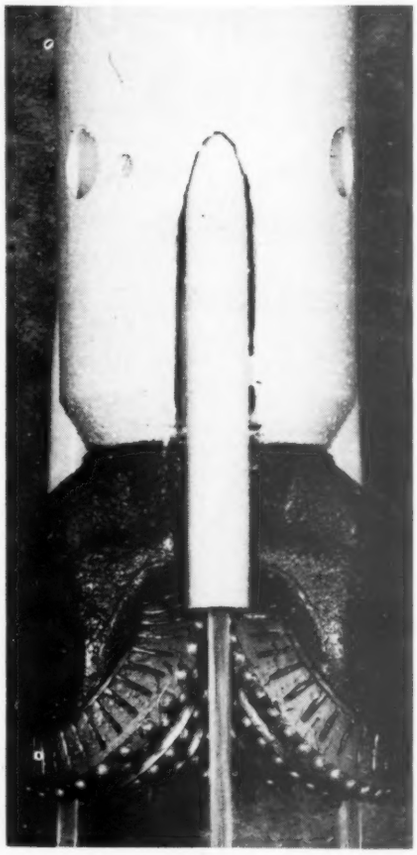
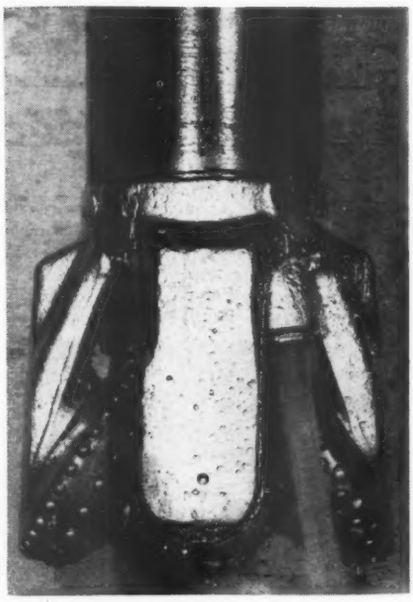


FIG. 5.

The West Texas Subcommittee of the Southwestern District Jet Bit Study Committee has been organized. This group intends to analyze jet rock bit results in the West Texas area with the hope of determining which formations can be drilled more economically with jet rock bits and what hydraulic conditions are needed to effectively use jet bits. In addition, it is intended to arrive at some recommendations concerning drilling equipment to allow greater available horsepower for the use of interested operators as they replace or purchase pumps, drill pipe, and drill collars. The interest in this group is very active as is the interest of most West Texas operators; and it is anticipated that a great deal concerning the use of jet rock bits will be learned in the coming year.

Chert Bits. Probably the most important improvement in hard-formation

FIG. 6.



bits for the past decade has been the development of the chert bit. Figs. 5 and 6 show two types of the chert bit, and several other manufacturers are known to be experimenting with similar bits.

The chert bit is a prime example of the old adage "never judge a book by its cover." When the bit companies were conducting initial tests with the bit about two years ago, most drillers expressed positive opinions as to how much hole that bald-headed dull bit would make. They were pleasantly surprised to discover that the bit would drill on an average of 5 to 7 times as much hole as a conventional bit and, in many cases, 10 to 20 times as much. Chert bits are expensive, costing around $1050 in the 8¾-in. size. The payout of the bit depends on the operating cost of the rig involved, amount of hole made with conventional bits, amount made with the chert bit, and whether reamer cutters can be omitted using the chert bit. One operator using a $50 per hour rig and no reamers with the chert bit estimates that the bit pays out if it makes as much hole as 2½ conventional bits. This is arrived at as follows, assuming the penetration rate of both chert and conventional bits is the same, which is usually true.

TABLE 5. Cost comparison. Chert vs. conventionals bits — 8¾-in. hole.

Chert		Conventional	
Cost of one bit...	$1050	Cost of 2½ bits..	$389
One trip.....	$ 200	2½ reamers.....	$338
		2½ trips.....	$500
	$1250		$1227

Various costs may raise or even lower economical rates for the bit at depths requiring slow trips; but in general, in formations containing 30 per cent chert or more, the bit can be used economically when conventional bit performance drops below 20 ft per bit. In any formation it is worth trying when conventional bit performance drops below 15 ft per bit. On a recent Humble well in eastern Andrews County, 8¾-in. bit performance was poor in the Mississippian at around 12,000 ft. Bits were making only 10 to 25 ft and the formation was hard lime with a small amount of chert. The first chert bit made 93 ft in 34 hours and the second made 100 ft in 35 hours. The bits were run with 30,000 to 35,000 lb at 30 to 35 rpm; and, considering the trip hours saved, their use was certainly justified.

There are many possible variations of the chert-bit construction, and it is believed that types of the bit will be developed that will reduce drilling time in all hard formations. The present bit utilizes spherical-nosed compressed tungsten carbide teeth and is effective in the very brittle formations that will drill by crushing. It is possible that sharp tungsten carbide teeth will cut the so-called tough formations such as the slow-drilling deep shales. Other possible variations are the use of the carbide compacts in the reaming edge of conventional hard-formation bits and a combination of carbide teeth and sharp conventional teeth on a bit to drill the broken chert and lime or shale formations often encountered in West Texas.

The chert bit has been used to drill broken formations in the following manner. As long as the drilling time stays normal for chert formations (5 ft per hour) the chert bit is used. If the rate slows, indicating shale or lime, the bit is pulled and a conventional bit is run until chert is encountered again. Experience is needed in an area to use the chert bit economically in this manner, but it does illustrate the possibility of the development of a bit using a combination of conventional teeth and the tungsten carbide compact teeth. Future development of bits using compressed carbide and possibly other metals will certainly reduce hard-formation drilling problems.

Straight Hole

It is estimated that at least 20 per cent of the holes drilled in West Texas are drilled with reduced weight through one or more sections because of crooked hole. The crooked-hole problem has increased with the trend toward high bit weights and is now at the point where a great deal of experimentation is being carried on in an effort to combat crooked hole. Most operators are using some forms of stabilization. Some are stabilizing through the use of reduced bit weight and, consequently, have less buckling in the drill-collar string; but this method is expensive because of the reduction in penetration rate with light weight. Others are using string reamers with smooth rollers placed at various places in the drill-collar string with the idea of reducing buckling. A common method of placing the stabilizers is to notice the shiny areas in the collar string and to install the reamers at these points with the idea that the shiny areas are caused by the collars contacting the walls of the hole.

Many operators are trying the various types of sleeve stabilizers now on the market. Either a bottom collar, usually equipped with four sleeves, or a sub with one sleeve is used or sometimes both. In fact, practically every conceivable combination of reamers, stabilizers, and sleeve-type stabilizer has been tried.

An increasing number of operators are using large drill collars. Humble has adopted the practice of using fifteen 7¾-in. collars in 8¾-in. hole; fifteen 7-in. collars in 7⅞-in. hole and eighteen 6-in. collars in 6¾-in. hole in all areas where the salt section is cased off and no abnormal drilling problems are expected. Several others use a combination string of 3 or more oversize collars directly above the bit, with the remainder of a size capable of being washed over. There is a definite trend toward larger collars, e.g., the use of the 7-in. collar in 8¾-in. hole. Seven-inch collars can be washed over (8⅛-in. O-D flush joint) in short intervals and offer better stabilization than the commonly used 6¼-in. collar, and also can have a 2¾-in. bore that reduces the hydraulic losses.

Two interesting facts concerning large drill collars have been noticed recently. In a recent API committee meeting where a number of operators using oversize collars and full gage sleeve-type stabilizers were represented, fishing for oversize strings was discussed. Not one operator has lost or had heard of anyone else losing a string of oversize collars in the West Texas area, nor had any operator found it necessary to wash over a sleeve type stabilizer. Undoubtedly large collars have been and will be lost in West Texas, but it does appear that the possibility of losing oversize collars is considerably less than generally assumed by most operators. The average fishing job with oversize bottom assemblies is stuck pipe, and is cleared up with the use of oil or a back-off shot and subsequent use of jars. In cases of drill-collar joint failure, a tapered tap may be used or a fishing neck can be cut with a diamond shoe to enable the use of an overshot.

Humble has used a string of fifteen 7¾-in. collars in 8¾-in. hole for 20 months without a collar failure; and recently it was found the average outside diameter of the collars is now 7⅝ in. This may be compared with the accepted average collar wear using smaller collars, which is ¼-in. of diameter per year for the West Texas area. This low rate of outside-diameter wear with larger collars is probably a result of reduction in buckling over smaller collars, reduced rotary speeds, and possibly because the high velocity of the mud in the restricted annulus with the large collars exerts some force to keep the collars from rubbing the walls of the hole.

In addition to stabilization, one other method of combatting crooked hole shows some promise. Percussion drilling has been experimented with for a number of years and has shown some tendency to drill a straight hole. Only a few percussion-type drilling tools have been developed, however, to the stage that they could be used for drilling enough hole to evaluate their straight-hole drilling or hole-straightening properties. Recently one tool has been developed by a major bit company that shows promise of being an aid to straight-hole drilling. Recent field tests have indicated that, at least in some areas, holes can be straightened with this tool and still maintain a reasonable rate of penetration. Another year should see a full exaluation of this and possibly other percussion-type tools.

All of the above-mentioned methods of combatting a crooked hole and drilling a straight hole have met with varying success and the most economical method has not been determined. The Southwestern District Study Committee on straight-hole drilling has been organized with members from West Texas organizations, inasmuch as the problem appears to be more serious in that area. The group is attempting to obtain information concerning the straight-hole drilling problems in the various West Texas areas and the method used in solving the problems. The ultimate aim of the group is to determine and advise interested parties in the industry of the most economical method or methods of combatting crooked hole. Considerable progress is expected next year.

XUM

Drilling Equipment

There are several items of drilling equipment that deserve some mention in any discussion of Permian Basin drilling. Air slips are now fairly common on the heavy rigs and, although some operators disagree, most feel that the safety features and labor saving of the air slips result in an over-all increase in rig efficiency which will justify the cost of power slips.

As previously mentioned in the jet-bit discussion, rotary-table torque indicators are an aid in determining the time to pull a bit. An increasing number of rigs are being equipped with some type of torque indicator, either a vacuum gage in the case of gas engines, or a rotary chain tension indicator for diesel powered rigs.

The drilling feed-off control or so-called automatic driller has proved to be a valuable aid in increasing penetration rates and thereby reducing drilling costs. A recent survey indicated that there were 67 rigs operating in West Texas with some type of feed control. Most of the controls are used on rigs rated as 9000 ft or deeper, and inasmuch as there are approximately 300 rigs of that size in West Texas, some 22 per cent of the heavy rigs utilize the drilling-feed control. One good comparison of rigs using the drilling-feed control occurred in the Yarbrough and Allen field. Eleven wells drilled over a two-year period were compared. All used essentially the same drilling practice with the exception that six were drilled by rigs without feed controls and five by rigs with a drilling-feed control. The five wells drilled by rigs with feed controls averaged 276 rotating hours less per well than the average of the six wells drilled without feed controls, which amounted to a reduction of 18 per cent in rotating time. A reduction in rotating time of this order certainly justifies the cost of a feed control. In addition to the reduction in rotating time, a minimum of twist-offs and crooked-hole difficulty was experienced by the rigs using the feed-off device.

The interest in automatic pipe-handling equipment is increasing. Several air-powered drill-pipe spinning tongs are now in use and automatic catheads are used practically universally. Humble's automatic rig has been in operation in West Texas for over a year; and although continued development with the equipment is necessary for it to replace conventional equipment, the equipment does handle pipe as fast and is capable of handling pipe faster than conventional equipment. The pipe is handled with a minimum of effort and offers a very safe method of handling drill pipe because no catheads are used and no personnel are near the drill pipe. Continued development of equipment of this type should enable the drilling industry to offer workers the opportunity of working until normal retirement, which might relieve a growing labor problem in the industry as well as allow the industry to profit by being able to work more experienced personnel.

Improved Drilling Practice

In the Yarbrough and Allen field, some 60 wells have been drilled by several operators. In mid-1951 the Humble Oil and Refining Company initiated a program to reduce drill and complete time and total well cost in the field. At that time Humble had drilled 20 wells with an average completion time for normal field wells of 110 days. The following practices were initiated: Oversize drill collars, jet rock bits, reduced rotary speeds, chert bits, and predrilled mouse and rat holes to reduce spudding time. The two rigs used are equipped with drilling-feed controls and are unitized for skidding and are able to skid and set surface pipe in less than 24 hours. The results of this program have been encouraging. The record time for the field was lowered to 94, 86, and 81, and on the latest well to 70 days total time from skid to skid. The best completion time reported by other operators is 98 days, with an average time of from 100 to 110 days. The combination of drilling practices used makes the evaluation of any particular item difficult, but the overall reduction certainly indicates the advantages that can be gained through improvements in drilling practice.

Future Trends in Drilling

There are some definite trends in West Texas drilling operations that appear to prognosticate future drilling practices and equipment. One of the most probable is the use of air or gas as a circulating medium. Remarkable results have been obtained, mostly in the San Juan Basin of New Mexico; and with an estimated 20 per cent of the West Texas footage capable of being drilled with a gaseous medium, progress in this field is certain to advance. There are numerous indications of equipment changes: Larger drill pipe; maximum-size drill collars in known areas and maximum to wash over in other areas; maximum-bore collars to reduce hydraulic losses; extensive use of jet-type bits; power pumps with greater horsepower; gas engines with more horsepower; and a tendency away from diesel engines because of the low cost of butane; an increasing use of air-powered automatic equipment and automatic drilling-feed controls.

Wells have been drilled to depths of over 15,000 ft in the area, and deeper tests are not far in the future. Abnormal pressures, although not as great as coastal pressures, have been encountered which will necessitate some revision in the usual West Texas casing program. To control any abnormal pressure in West Texas, it is necessary to have a string of casing set through the usual lost-circulation zones. In the deeper areas, this would require from 10,000 to 12,000 ft of casing. The cost of drilling a 12¼-in. hole to set 9⅝-in. casing or an 11-in. hole to set 8⅝-in. casing at these depths would be practically prohibitive. It seems likely that future deep tests will carry 8¾-in. hole, and if a deep protective string is needed, will use 7⅝-in. slim hole or 7-in. casing and drill to total depth with a hole size from 6¾ to 6-in. It is common practice in the West Texas area to set 5½-in. casing in 6¾-in. hole; and it is possible to set 5-in. casing in 6-in. hole.

Needless to say, the future drilling practices in West Texas will be interesting and reductions in drilling time and cost will be made. The drilling industry has been, and will continue to be, progressive as long as the present healthy competition exists. With the majority of the West Texas area yet to be explored, and with some 500 rigs competing in the area, progress in hard-rock drilling will continue.

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1. Johnston, David: *Hard Rock Drilling in the Permian Basin*, Drilling and Production Practice, 50 (1947).

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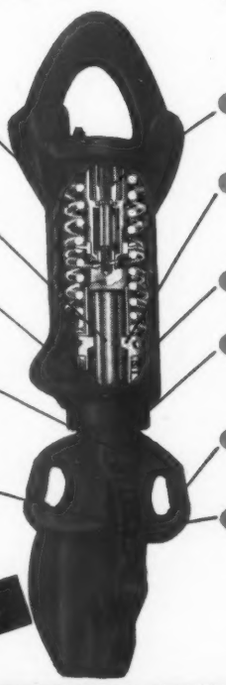

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Navy to Quit Alaska Oil Exploration

Secretary of the Navy Robert B. Anderson has reported that the Navy Department is making an "orderly withdrawal" from Pt. Barrow, Alaska. Naval department engineers began the project in 1944 to survey oil reserves in that area. Anderson also reported that a request to Congress to give $9,700,000 to carry on the work next year had been cancelled.

Capt. Robert H. Meade, director of Naval Petroleum Reserves, stated that the decision to withdraw men and equipment from Pt. Barrow was made because future operations would be too expensive to justify continuing the work.

Armed Service Committee was told that $50,000,000 had been spent so far in the oil search and $13,480,000 more had been appropriated. Meade testified that there is still a good chance substantial quantities of oil could be found, but it would have to produce about 100,000 bbl per day to be economically feasible.

Oil Prospects Said Good In Los Angeles Harbor Area

A structural oil trap may exist under Los Angeles outer harbor in "commercially important quantities" and it is recommended that "every effort" be made to slant drill from an upland location near main channel entrance, according to a geology and oil prospects report made to the Los Angeles Board of Harbor Commissioners by W. H. Geis, oil geologist.

Oil prospect report of the 7000-acre. $125,000,000 harbor was submitted following an 8-month survey by Geis and a staff of experts.

The new structure, Geis said, may be part of the Los Angeles basin or Catalina Island provinces. Apex of the trap in either case is adjacent to the Los Angeles harbor breakwater entrance, and is approximately bisected by the breakwater line recommended in the report of the special master to the United States Supreme Court, as dividing the inland waters, owned by the city, from the marginal sea.

"It is believed that the prospects are sufficently attractive to lead a prudent oil operator or company to consider favorably exploration in the area.

"It seems reasonable, due to the proximity of the Los Angeles harbor anticline to the very prolific Wilmington field, (700,000,000 bbl in 17 years, now 100,000 bbl per day) that if any oil is found beneath the harbor it should at least be in commercially important quantities," the report added.

Houston Geological Group Releases New Type of Map

The Houston Geological Society has released the first in a series of geologic strip maps of Texas highways. This initial map covers portions of highways 75 and 77 from Galveston through Houston, Conroe, Corsicana, Dallas, and Denton, to the Texas-Oklahoma state line.

The maps are prepared by the Highway Strip Map Committee of the Houston Geological Society, under the direction of F. W. Rolshausen, chairman, and are intended to reveal to the traveller the names of the geologic formations he is crossing, the oil fields he passes, and other information of interest along the way. They cover an area of about four miles on each side of the highways.

Copies of the map may be ordered from Dr. Frank J. Gardner, Secretary of the Houston Geological Society, Box 331, Houston, Texas. Price of the maps is $1.50 per copy.

API District Spring Meet Planned in Los Angeles

In preparation for the annual Spring Meeting of the Pacific Coast district of the American Petroleum Institute, Division of Production, to be held June 2-3 at the Statler Hotel, newly appointed members of the General Arrangements Committee recently met with other working committee heads in the first planning session.

Headed by B. K. Thorpe of Mills Iron Works, the general arrangements committee is composed of: Finance, Ed O. Peschke, Baker Oil Tool; Publications, Clayton E. Rose, Axelson Manufacturing; Hotel Arrangements, Max A. Klepfer, Bethlehem Supply; Tickets, William Anderson, Oil Tool Corporation; and Publicity, D. H. Stormont, Oil and Gas Journal.

General chairman of the spring meeting is Milan G. Arthur of Union Oil Company of California. Program committee chairmen are C. F. Gates of General Petroleum, production sessions, and D. S. Johnston of Signal Oil and Gas Company, drilling sessions. T. H. Acres, Sunray Oil Corporation, is chairman of the Pacific Coast district.

New Vickers Exploration Company Begins Wildcat

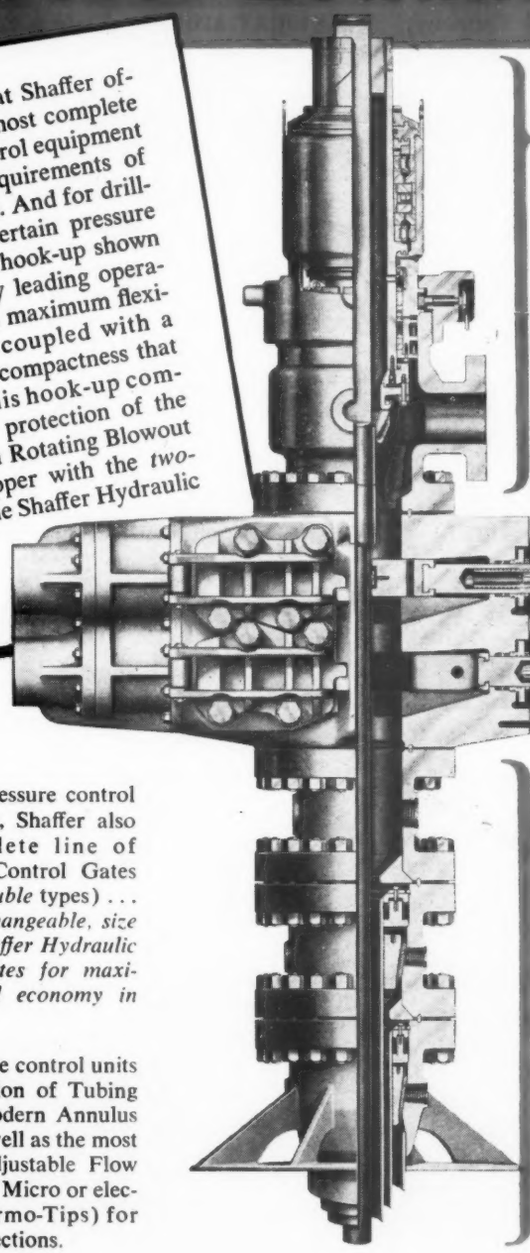
Jack A. Vickers, Jr., president of the Vickers Petroleum Company, Inc., has announced formation of Vickers Explorations Ltd., a partnership operation originated for the purpose of drilling and producing oil and gas properties in Texas, New Mexico, Oklahoma, and Kansas.

The new enterprise has begun drilling its first test well, the Vera A. Crawford No. 1. Test well, projected to reach a total depth of 9600 ft, will test the Springer sand section.

The Texas Company's producing committee met in New York recently. Attending were: Seated, J. H. Rambin, Jr., division manager, Louisiana; S. A. Berthiaume, assistant to general manager, and A. R. Wilson, assistant general manager, Houston; E. R. Filley, vice president, R. F. Baker, executive vice president, New York; J. N. Troxell, general manager, J. C. Brooks, assistant to general manager, Houston; C. B. Williams, division manager, West Texas division; A. W. Baucum, assistant to vice president, New York. Standing, J. O. Bower, manager, Colombian division, Texas Petroleum, Bogota; J. H. Puls, division manager, Pacific Coast Division; E. M. Jacobs, department agent, Houston; G. Herzog, director of research, Bellaire; M. L. Terry, division manager, Oklahoma division; D. L. Harlan, chief petroleum engineer, W. V. Vietti, division manager, gas division, R. L. Lay, division manager, geophysical division, Houston; T. T. Freeman, division manager, Rocky Mountain division; W. A. Clark, general manager, foreign producing, New York; T. W. G. Thomson, manager, Texaco Exploration, Calgary; G. M. Clement, chief geologist, Houston; B. M. Miller, staff geologist, New York; L. T. Tighe, division manager, South Texas division; H. H. Arnold, Jr., vice president, Caltex, New York; G. A. Severson, assistant manager, Venezuelan division, Texas Petroleum Company, Caracas, Venezuela; L. J. Whetsell, director, industrial relations, Houston; W. J. Hanley, New York staff; H. Brunjes, New York staff, and A. C. Hunter, assistant to general manager, New York City, New York.

3 REASONS *why this Shaffer Hook-Up is the* Choice of Leading Operators!

It is a recognized fact that Shaffer offers the oil industry the most complete selection of pressure control equipment to meet the varying requirements of different field conditions. And for drilling under high or uncertain pressure conditions, the Shaffer hook-up shown at right is preferred by leading operators because it permits maximum flexibility of operation, coupled with a degree of safety and compactness that are unsurpassed. This hook-up combines the *automatic* protection of the Shaffer Combination Rotating Blowout Preventer and Stripper with the *two-way* protection of the Shaffer Hydraulic Double Cellar Control Gate . . .



1 ***THE SHAFFER COMBINATION ROTATING BLOWOUT PREVENTER AND STRIPPER*** provides—*in one unit*—every necessary feature for successful and simplified pressure control while the drill string is in the hole . . .

- It *automatically* maintains a continuous seal around different shaped elements in the drill string — square, hexagon or round — regardless of whether the string is rotating, being raised, lowered, or is stationary.
- The seal *automatically* expands and contracts to fit the varying diameters of drill pipe, tool joints, couplings and drill collars.
- Bits, reamers and other abnormally large tools can be easily passed through the unit by merely turning the Quick Releasing Bonnet 1/6 turn and removing the sealing assembly. It's simple, quick!

With no valves to open or close, nothing to remember, *nothing to forget* in the excitement of pressure emergencies, this unit gives *continuous* protection while the drill string is in the hole!

2 ***THE SHAFFER HYDRAULIC DOUBLE CELLAR CONTROL GATE*** provides—*in one unit*—rams for shutting off the well when pipe is in the hole, as well as rams for sealing off open hole.

- Rams are opened and closed by *direct* hydraulic drive in a completely enclosed unit. No complicated yokes or secondary connections, no exposed moving parts to become wedged or damaged.
- Even in sizes as large as 13⅜" (12" Series 900) the complete unit, including *two* ram compartments, requires only 30" cellar height—smaller sizes even less!
- Rams can be easily changed—whether the pipe is in or out of the hole—by simply opening two doors in the side of the gate . . . the simplest, quickest ram changes in *any* gate!

There are many other vital advancements—and the same basic features are also available in the Shaffer Hydraulic *Single* Cellar Control Gate, if this design desired.

3 ***SHAFFER LANDING AND CASING HEADS*** are recognized throughout the industry for their rugged dependability and adaptability to various suspension and pack-off requirements. The bottom unit at left is a Shaffer Base Head from which two strings of casing are suspended and packed-off with maximum compactness . . . and in the Head above it a third string is suspended and packed off.

With the casing program known in advance, the complete drilling and casing program can be completed without changing drilling connection, including gates, either in size or length during drilling of well.

Other types of Shaffer Heads and packing arrangements—including Shaffer Combination Base, Casing and Tubing Heads in one *unit*—are also available to meet virtually any well-completion requirement.

In addition to the pressure control units shown at right, Shaffer also provides a complete line of *Mechanical* Cellar Control Gates (both *Single* and *Double* types) . . . *and rams are interchangeable, size for size, between Shaffer Hydraulic and Mechanical Gates for maximum simplicity and economy in field operations.*

Other Shaffer pressure control units include a full selection of Tubing Heads (featuring modern Annulus Flange types) . . . as well as the most complete line of Adjustable Flow Beans (with Conical, Micro or electrically-heated Thermo-Tips) for use in the flow connections.

FROM SPUD-IN THROUGH PRODUCTION, BRING YOUR PRESSURE CONTROL PROBLEMS TO SHAFFER!

For complete data on any of the above units — or any other Shaffer product—see your nearest Shaffer representative. Or write direct!

Send for your copy of the 1951 Shaffer Catalog.

See pages 4525 to 4600 of your 1951 Composite Catalog.

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XUM

API COASTAL chapter officers are: Paul Turner, Union Truck Company, treasurer; Walt Lupton, Shell Oil, chairman, and Boyd Grainger, Tide Water Associated Oil Company, secretary for the coming year. John McCabe, not shown, was chairman for the meeting held in Ventura, California. New executive committee members are Lupton, John Van Riper, Don Sweet, Paul Tuttle, Don Priest, and Frank Minchel.

SPEAKER AT AIME dinner held in Los Angeles recently was Walter T. Wells, chairman of the board, Lane-Wells and Superweld Corporation. He was introduced by A. T. Cape, vice president, engineering, Superweld. Wells' speech was entitled "Building Business," and his remarks were addressed especially to the younger men attending the meeting.

THE WORLD LEADER
FOR STABILIZING OR REAMING—
SECURITY REAMERS LEAD THE FIELD
A Security Reamer-Stabilizer in your drill string is your greatest assurance of a clean, straight, full-gauge hole.
Security's 22 years of successful laboratory research and development, combined with practical field engineering and experience, has gained for Security Reamers their leading position in reaming and stabilizing.
Whether it's reamers, rock bits, hole openers or casing scrapers—Security products are geared to the stepped-up requirements of today's intensified drilling efforts, and are being used by operators throughout the world.
Three barrel-shaped cutters contact over one-third wall circumference—acting as cutters and as large roller bearings. Unexcelled for reaming, directional drilling, minimizing keyseating, stabilizing, etc.
GET Security IN DRILLING
SECURITY ENGINEERING DIVISION
DRESSER OPERATIONS, INC.
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BRANCHES IN ALL MAJOR PRODUCING AREAS
ROCK BITS • REAMERS • HOLE OPENERS • CASING SCRAPERS • SECURALOY

District Officers Named

Watt Lupton, Shell Oil Company, was named chairman of the California Coastal Chapter of the American Petroleum Institute, Division of Production.

Other officers elected at a recent meeting include: Paul Turner, Union Truck Company, treasurer, and Boyne Grainger, Tide Water Associated Oil Company, secretary for the coming year.

Elected to the executive committee were: Lupton, John Van Riper, Continental Oil, first vice chairman, and Don Sweet, Richfield Oil, second vice chairman. On the Advisory Committee, second year advisors, are: Paul Tuttle, Western Gulf; Don Priest, General Petroleum, and Frank Minchel, Continental Oil.

Wells Speaks at AIME Meet

Walter T. Wells, chairman of the board of Lane-Wells Company, technical oil field services, and chairman of Superweld Corporation addressed more than 200 metal men at the dinner meeting of the metals division and the iron and steel division of the American Institute of Mining and Metallurgical Engineers Convention in Los Angeles recently. A. T. Cape, vice president—engineering, of Superweld, introduced Wells.

Wells' subject was "Building Business," and he addressed his remarks primarily to younger men. He told of the problems in developing a new business from a small one into a large one and cited some helpful information from his personal experience in building Lane-Wells from a small beginning in Los Angeles in the depression year 1932, to one of the world's largest organizations.

AIOC Oil Surveys Are Completed in Sicily

Completion of geological and gravity surveys for oil in Sicily by the D'Arcy Exploration Company, prospecting subsidiary of Anglo-Iranian Oil Company, is announced by the company. A seismic survey, due to finish in mid-March, is now being carried out.

Since June, 1951, when Anglo-Iranian was granted permits to search for and produce oil around Ravanusa, Vittoria, and Priolo in southern and eastern Sicily, intensive exploratory work has been carried out.

— now you see why we can reach you *Quick!*

If you take this map and compare it with a map of the country's oil producing areas, you'll see at once that practically every active field is only minutes away from one of Lane-Wells 72 branches. And each of these branches is ready, round the clock, to provide operators on-the-spot on-the-dot service with up-to-date equipment operated by thoroughly trained and experienced men who know local conditions. That fast, dependable service is one reason why operators agree that you get *better* perforating when Lane-Wells does the job.

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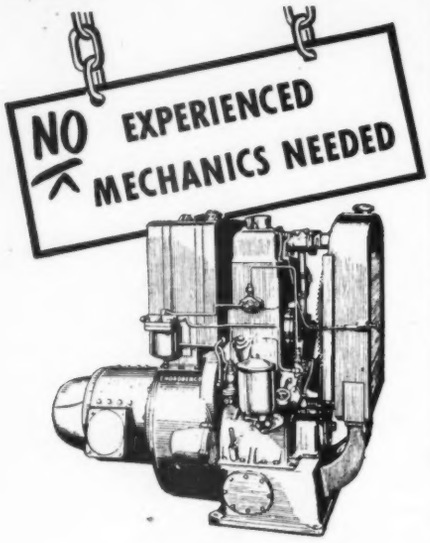

. . . NORDBERG DIESEL ENGINES are easy to operate— simple to maintain

You just don't need special mechanical training to operate and maintain Nordberg "4FS" Diesel engines.

Their basic design and construction makes them easy to start and easy to keep going—day in, day out, with a minimum of attention. Routine maintenance is extremely simple . . . all parts are easy to get at.

These are reasons why Nordberg 1, 2 and 3-cylinder "4FS" Diesels are more and more in demand for all kinds of power jobs from 10 to 45 hp —for electric service from 6 to 30 kw (6,000 to 30,000 watts)—and for pumping jobs from 200 to 3000 gpm at 15 to 240 ft. total head.

Mail the coupon for full details.

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Send catalog covering Nordberg Type 4FS Diesels. I am interested in a unit for the following service:

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4-253

Deep Rock Establishes North Dakota Office

Deep Rock Oil Corporation has announced that its expanding operations in the Williston Basin area include the establishment of an area land and exploration office in Bismarck, North Dakota.

John L. Ferguson, vice president of land and exploration, also announced expansion of Deep Rock area offices in Wichita Falls and San Antonio, Texas. Expanded operations in these two offices have resulted in the promotion of F. E. Melott to Wichita Falls area manager and M. E. Forney to San Antonio area manager.

Among the changes announced by Deep Rock was the appointment of William Ford of the Tulsa production division as economic assistant to Ferguson, and the transfer of R. B. Hurlbutt of the company's Shreveport, Louisiana, office to be assistant to the manager of the geological department in Tulsa.

Named to the new land and exploration area office in Bismarck are Harry W. Hitt, area landman, and John C. Meyer, area geologist, who were transferred from Deep Rock's Midland, Texas, office, and M. R. Reston, landman, transferred from the Calgary, Alberta, office.

In the new land and exploration area office in Tulsa, I. S. Higginbotham has been named area geologist. L. L. Crozier has been appointed area landman; J. L. Roach, geologist; and H. L. Curry, scout.

Higginbotham, Curry, and Roach were shifted from other Tulsa positions, while Crozier was transferred to the Tulsa area office from Oklahoma City.

Don Billings, scout, was transferred from the Midland office to the San Antonio staff; Nolan Hirsch, geologist, of the Midland office will remain in Midland to man Deep Rock operations; James Law, geologist, of the Shreveport office will oversee company operations in the Shreveport area. R. W. Bayliss, scout, was shifted from Oklahoma City to the Denver office; and C. D. Moore, geologist, will remain in the Oklahoma City office.

Water Flooding May Raise Oil Flow in Oklahoma Field

An additional production of oil up to 100,000,000 bbl might be recovered from the Healdton oil field of Carter County, Oklahoma, by water-flooding, according to a petroleum-engineering report released by J. J. Forbes, Director of the Bureau of Mines, Department of the Interior.

Dr. C. W. Seibel, regional director of the Bureau's Region VI, said that the Bureau engineers who prepared the report estimate only a small per cent of the more than 200,000,000 bbl still in the Healdton sands is likely to be produced by present operating methods.

The report was prepared by C. H. Riggs, John E. Wey, Edward Sanabaria, Jr., and Paul Meadows of the Bureau's Petroleum Experiment Station in Bartlesville, Oklahoma, and William C. Smith, and James A. West, former Bureau petroleum engineers.

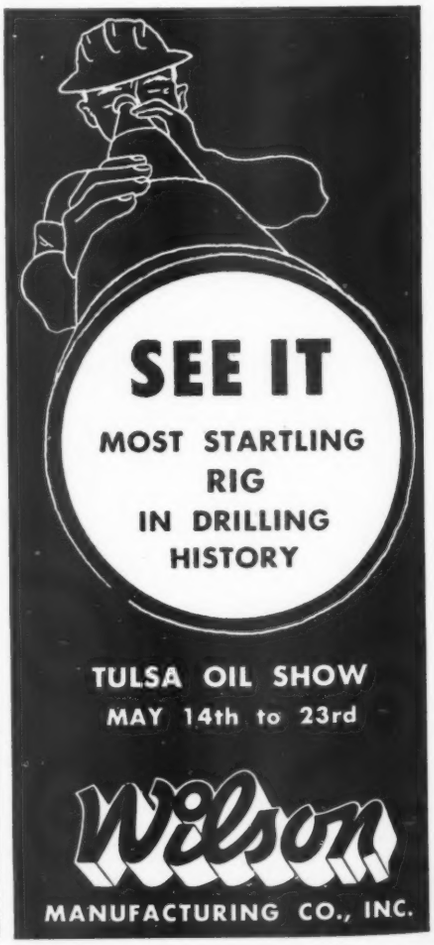
Healdton field has produced more than 200,000,000 bbl of oil from about 2600 wells since its discovery in 1913. Approximately 7142 acres comprise the field. The richest producing beds are the Healdton sands, which average 72 ft in thickness at depths between 700 and 1400 ft.

Natural gas pressure is nearly exhausted in the field. After small attempts to increase production by air and gas injection failed to bring adequate results, the Bureau studied the field to determine the benefits that might be expected from the water-flooding method.

Houston Firm Forms Production Subsidiary

The Houston Natural Gas Production Corporation has been formed in Houston, Texas, as a wholly-owned subsidiary of Houston Natural Gas Corporation. Dr. Bryon B. Boatright, consulting petroleum and natural gas engineer, has been elected vice president and general manager of the company. Other officers include: Frank C. Smith, president, J. H. Wimberly, executive vice president; John B. Cookenboo, treasurer; and Kenneth Fellows, secretary, all of Houston. In addition to the officers, directors include Joseph F. Wolff of Corpus Christi.

The new producing firm will participate in oil and gas development as well as acquisition of gas reserves.



UNIONS ARE OUR BUSINESS

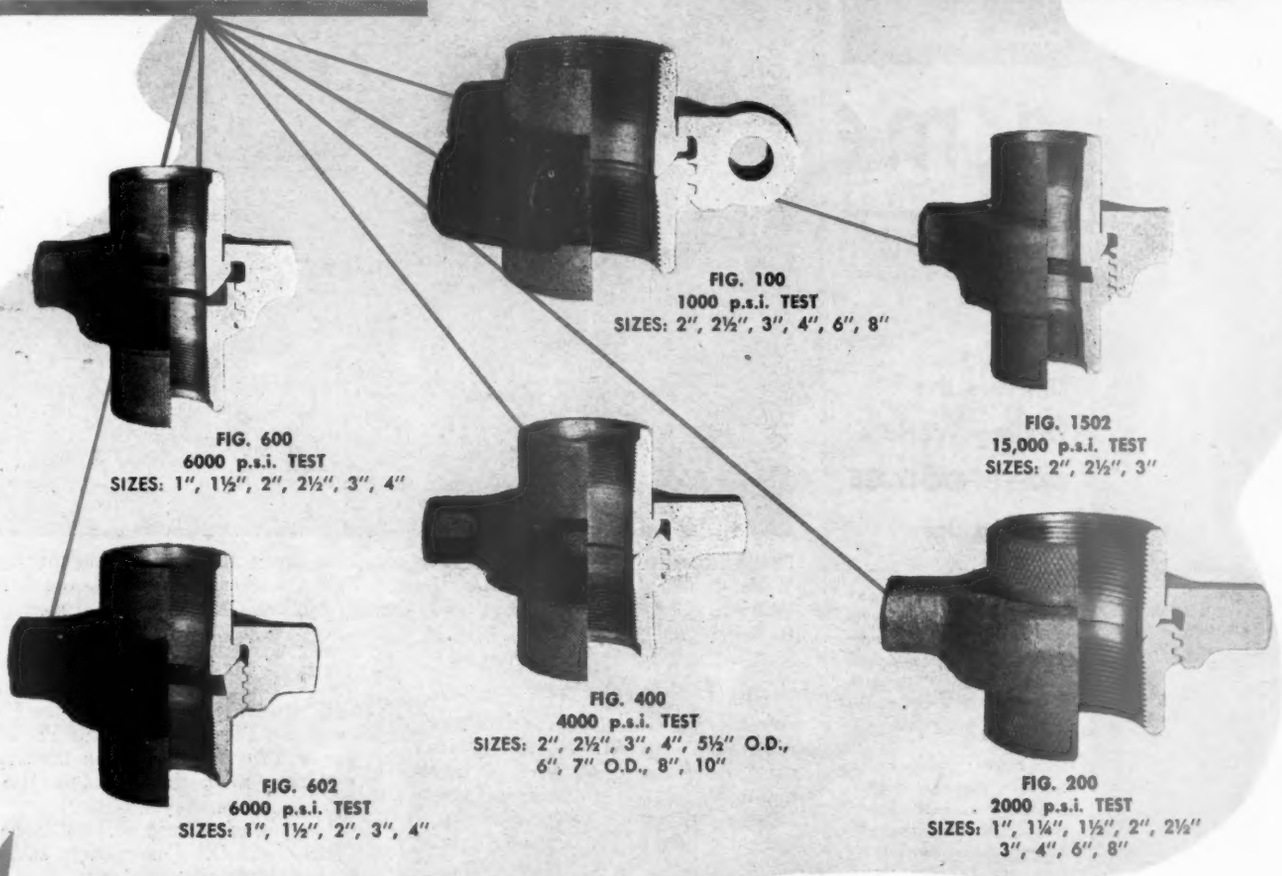


FIG. 100
1000 p.s.i. TEST
SIZES: 2", 2½", 3", 4", 6", 8"

FIG. 600
6000 p.s.i. TEST
SIZES: 1", 1½", 2", 2½", 3", 4"

FIG. 1502
15,000 p.s.i. TEST
SIZES: 2", 2½", 3"

FIG. 400
4000 p.s.i. TEST
SIZES: 2", 2½", 3", 4", 5½" O.D., 6", 7" O.D., 8", 10"

FIG. 602
6000 p.s.i. TEST
SIZES: 1", 1½", 2", 3", 4"

FIG. 200
2000 p.s.i. TEST
SIZES: 1", 1¼", 1½", 2", 2½" 3", 4", 6", 8"

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• **Almost 20 years ago we pioneered Acme-thread wing-nut unions for the oil industry and have devoted our engineering skill and manufacturing craftsmanship to their production and improvement ever since.**

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Whatever your service requirements, there is a WECO Union that is exactly right for the job. And this, we believe, is the basis for longer service and maximum economy from unions.

Ask your WECO Representative or your Supply Store for the WECO Union that will give you the utmost in economy and service wherever unions are needed.

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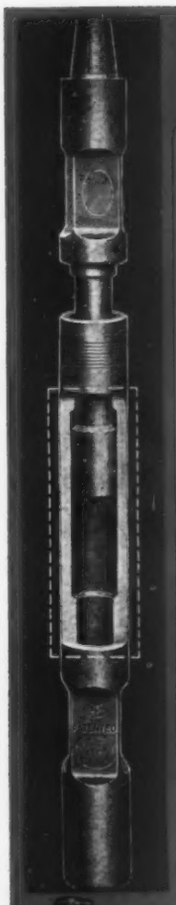

Greatest Name in Cable Tools

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TRUSTWORTHY SINCE 1900

Delivers the Drilling World's MOST FOOTAGE Drilling Jars

(Fig. 105) Weldless, of alloy steels. Heat-treated for greatest toughness. DOUBLY outwear welded Jars. Prevent Jar-troubles that cause COSTLY fishing jobs.

Cylindrical construction means more "stock;" greater wearing surfaces; added strength. Swivel action assures free-tool turning; good hole.

Every inch, the Drilling World's FINEST Jars . . . Made under most favorable Jar-making conditions, by long-seasoned Jar-specialists.

(Fig. 107) Making welded Jars — of PREMIUM grade steel, correctly heat-treated — is the work of full-time, long-experienced Jar-crews at Acme. Throughout heating, forging and welding, their pride-of-craft abilities are co-ordinated in fashioning a superior quality product.

Buy welded Jars on a comparative Jar-service basis . . . and you'll buy Acme's 9-times-in-10.

Write for Complete Information — including prices — on these SUPERIOR Acme Cable Tools.

There's More of EVERYTHING You Need in Acme Tools . . .

Acme's famous "Drilmor" Line not only provides a tool for every drilling or fishing operation but each tool possesses more of the finer functional features and superior product qualities you need for better in-hole results . . . because specialized toolmanship of over half-a-century accounts for the difference.

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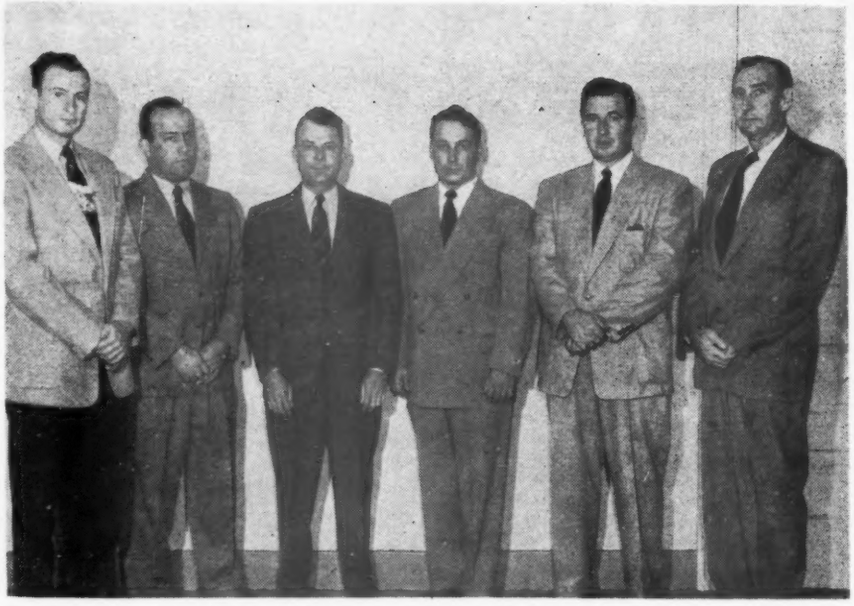
PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION MEMBER



New officers of Seminole, Oklahoma, chapter of American Petroleum Institute include: Walter E. Bailey, 3rd vice chairman; Jesse T. Nutter, 4th vice chairman; James R. Marty, chairman; L. Allan Brandon, 2nd vice chairman; Bill Lohmann, 1st vice chairman, and W. R. Bell, secretary and treasurer.

Spring Field Trip Set

West Texas Geological Society's 1953 spring field trip will be held Friday, May 29 and Saturday, May 30 in the Chinati Mountains of Presidio County, Texas—north of the town of Presidio. On Friday, a study of Permian reefing and Permain and Pennsylvanian rocks will be made. On Saturday, the Cretaceous and Permian Rocks of Pinto Canyon will be examined with the trip terminating near the town of Ruidosa, Texas, on that day.

Leaders of the trip will be: Robert H. Cress, Gulf Oil Corporation and Cecil C. Rix, University of Texas.

Registration for the trip will begin at 3:00 p. m., Thursday, May 28, in lobby of Paisano Hotel, Marfa, Texas.

Great American Acquires Interest in Sunset Oil

A joint announcement by J. D. Sterling, president of Sunset Oil Company in Los Angeles and B. L. Majewski, president of Great American Oil Company in Chicago reveals that Great American Oil Company has acquired an important interest in the Sunset Oil.

Sterling also announced that Sunset Oil is embarking on an extensive expansion program involving refinery enlargement and expanded exploration and oil producing activities.

Majewski has been elected a member of Sunset board of directors.

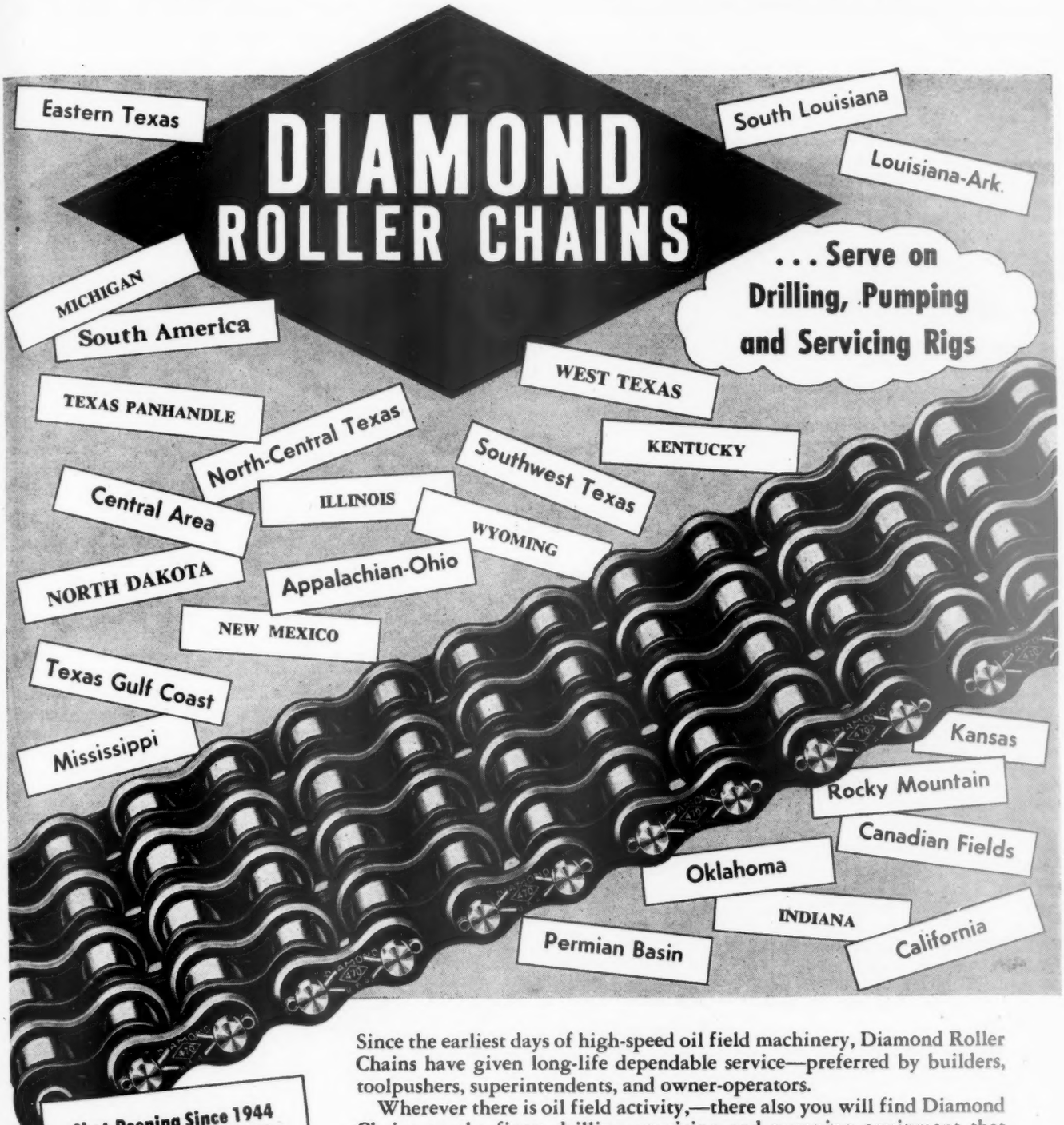
Shell Sets Up New Office

Shell Oil Company has established a new district production office in Brea, according to an announcement from P. E. Lehr, division production manager in Long Beach.

New and larger office facilities, heretofore situated in Brea Canyon, were necessary because of the company's expanding drilling and production operations in the Brea Canyon, Olinda, Yorba Linda, Santa Fe, and Montebello oil fields. Shell's current total crude oil production from the five fields is approximately 13,000 bbl per day.

R. A. Malott has been appointed district superintendent in charge of the Brea office, 103 South Pomona Avenue.

IN ALL ACTIVE OIL FIELDS



Shot-Peening Since 1944
Diamond Chain has long recognized that certain types of internal stressing of chain parts would increase fatigue resistance. To this end, link plates have been specially processed and chain rollers and other parts have been shot-peened since 1944.

And
Patented BCL Connector
The patented bushed center plate connector for multiple-strand press fit center plate chain has simplified connecting and disconnecting and assures full value in the chain at the connecting link.

Since the earliest days of high-speed oil field machinery, Diamond Roller Chains have given long-life dependable service—preferred by builders, toolpushers, superintendents, and owner-operators.

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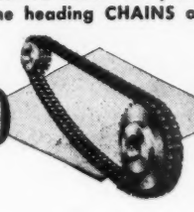
DIAMOND  ROLLER CHAINS

To obtain more information on products advertised see page E-59

What's Doing in Drilling

CALIFORNIA

• Discovery of an additional new producing zone in the Chowchilla, California, gas field area was announced by Tide Water Associated Oil Company following completion of its Redman Stone No. 1-20 well flowing at an estimated rate of 7,000,000 cu ft daily through a restricted choke under pressure ranging from 600 to 1100 psi. This well was drilled to a depth of 2971 ft and after running casing a 10-ft portion of this new zone was perforated at 2894-2904 ft.

Initial completion was delayed by equipment failure which resulted in a blowout. The well was then promptly rehabilitated and completed as a highly commercial gas producer.

• Tide Water also had announced successful completion of its McGonigle Number 27 well, Ventura Avenue field, California, flowing at the rate of 514 bbl net oil per day, gravity 34.7, from a total depth of 13,582 ft.

Tide Water Associated also announced completion of its Quati Number 98 well, Zaca field, California, pumping at the rate of 269 bbl net oil per day, from a total depth of 3217 ft.

TEXAS

• Lion Oil Company announced the completion of the Edwards No. 1, a one-mile extension of the North Bronte field, Coke County, Texas. In a potential test, the well flowed at the rate of 285 bbl per day on a small choke from the Ellenburger formation. Lion's Mary No. 1 in this same field, completed in December in the Gardner formation, has now been dually completed in the Goens formation. This discovers a new producing horizon in the North Bronte field. The well tested 167 bbl per day on a small choke from the Goens formation. Original flow from the Gardner was 867 bbl per day.

• Humble Oil and Refining Company has completed a new find in the Danbury field in Brazoria County. The No. 1 Danbury Gas Unit 4 flowed 335 bbl on a medium-sized choke, from the lower Frio formation, considered by the company to be a new production zone. Oil of 32.5 gravity is flowing from 8708-16 ft.

GEORGIA

• Stanolind Oil and Gas Company has completed the No. A-6 St. Regis Paper Company in the Pollard field of Escambia County. The new well is flowing at the rate of 130 bbl of oil per day through 7/64-in. choke, flow was cut with 0.2 per cent basic sediment and water. Tubing pressure was 280 lb, casing pressure 250 lb. Gravity of oil is 29 deg. Hole was drilled to 6157 ft.

MONTANA

• Shell Oil Company has extended the Pine Unit field in Wibaux County ¾-mile southeast with completions of its No. 32-32. Fifth producer for the field, the well recovered free oil, some gas, and a lot of gas-cut and oil-cut mud. on a series of drillstem tests. Tests were made between 8889 and 9100 ft.

The state's wildcat in Sheridan County recovered 125 ft of mud highly cut with gas and oil from 6988 ft to 7006 ft. It is Deardorf-Shepherd No. 1 Pohle.

NEW MEXICO

• A new discovery zone is apparent in the Mescalero Devonian field in Northwest Lea County. It is McElroy Ranch Company and Arkansas Fuel Company's No. 1-BT State, where on a drillstem test, oil reached the surface in 45 min at the estimated rate of 10 bbl an hour. Gas-oil ratio was 1000 to 1. Showing was made in the Hueco zone at 8172-222 ft. Hole was deepened for a second test at 8232-61 ft for recovery of gas-cut mud with some oil show.

• Sinclair Oil and Gas Company is extending the Denton Devonian field production with its No. 1 Whitman in Lea County. The new well flowed 9 hours for a calculated 2568 bbl of 46.5 gravity oil a day through a ¾-in. choke. Flow is from 12,350 to 12,415 ft, and gas-oil ratio was 540 to 1.

CANADA

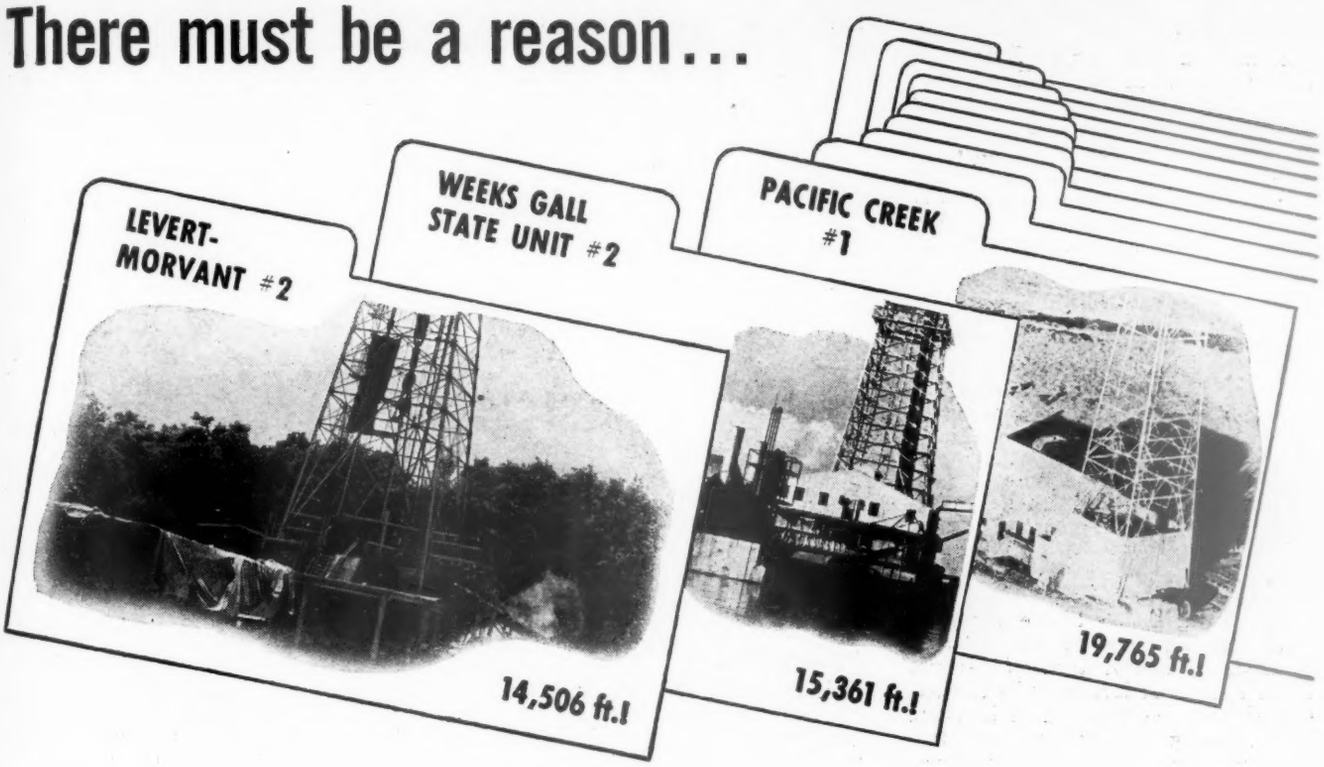
• Stanolind Oil and Gas Company has completed its St. Albert Unit No. 2 near Edmonton, Alberta. On a 14 hour test the well flowed 217 bbl of oil on 14/64-in. choke. Well's calculated production is 372 bbl per day. Oil, which is producing from the D-3 reef, is 34 deg gravity. Total depth of the well is 4711 ft.

• Britco Oils Ltd., reports that the second well on a quarter-section in the Namao oil field, north of Edmonton, purchased by a group of five independent Canadian oil companies, has been placed on production. The well, Antone-Trans Era-Britco et al Namao No. 2, is a south offset to the No. 1 well, which rated initial potential of 240 bbl daily.

PANEL MEMBERS discussed jet bits before Fort Worth-Dallas chapter, American Association of Oilwell Drilling Contractors. They are: George Cannon, Humble; W. E. Scarborough, Reed Roller Bit; Harold Nolley, Hughes Tool, panel moderator; J. D. Poe, Loffland Brothers; A. B. McLemore, Holmes Drilling, and John Rhea, Southeastern Drilling.

AAODC OFFICERS of the Fort Worth-Dallas chapter above include: E. Dale Mount, vice president, Harry Bass Drilling, chapter chairman; William P. Clements, Jr., general manager, Southeastern Drilling, program committee chairman; Mark Gardner, vice president, Delta Gulf Drilling, member of program committee; C. J. Davidson, president, Davidson Drilling, chapter vice chairman, and Mark Hart, vice president, Rowan Drilling, program committee.

There must be a reason...



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Unaflo's *retarded* set keeps slurries fluid and pumpable during the entire period of retardation despite heat and pressure. Unaflo's setting time is *delayed* not just slowed.

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3. HARDENS NORMALLY—**Unaflo, after its retarded period, makes a strong, tight seal** — **resistant to sulfate waters.**

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XUM

Drilling

LOUISIANA

• A new oil discovery by Sunray Oil Corporation at its No. 1 E. T. Daly, et al, Northwest Branch field, Acadia Parish, Louisiana, has been announced as flowing at the rate of 308 bbl of 53 gravity oil per day. Well was perforated at 10,843-48 ft and is producing from 55 ft of net sand thickness in a 112-ft section of the zone separated by shale breaks. The test was on a 10/64-in. choke. 2500 lb tubing pressure, and gas oil ratio of 2370 to 1.

• Stanolind Oil and Gas Company is completing its No. 1 Davis "B" in the Cameron field of Cameron Parish. The new well is ½ mile from the discovery well, and flowed 185 bbl of 32 gravity oil in 24 hours through a ⅛-in. choke. Production is from a Miocene sand plugged back depth of 10,916 ft. Total depth is 11,600 ft.

PORTABLE RIG

• A new rig is now in use along the Gulf Coast. Equipped by Wilson Manufacturing Company, Inc., of Wichita Falls, Texas, and fabricated by Henderson Welding Works, Inc., of Houston, Texas, this rig is one that answers highway load limit and weight problems. The one in photos below is owned and operated by C-B Drilling Company, 2480 Times Boulevard, Houston, Texas.

Weight restrictions on the highways, and the prospect of still further regulation in the future were factors behind the design of the new portable rig. The weight and transportation limitations have been overcome by ingenious splitting of the load onto two trailers. This is very much in contrast to the present methods of combining all units on one hauling base. The single unit or trailer system has long been a questionable subject in highway departments throughout the country. So much so that authorities have talked legislation to ban certain types of equipment or loads.

All the features designed and built into this rig were done so to help the contractor. A rig such as this now limits the time on rigging and moving to a matter of a very few hours and minutes.

COLORADO

• Lion Oil Company's first oil production in Colorado and in the Julesburg Basin was announced by T. M. Martin, Lion president. Downing No. 1 situated in Washington County, Colorado, was completed as an extension of the Little Beaver Creek field and is flowing at the rate of 524 bbl per day.

• The Little Beaver field in Washington County is being extended nearly a mile north by Triangle J. Oil Company's No. 1 Kugal. After perforating the "J" sand zone at 5330-45 ft, the well blew an estimated 18,000,000 ft of gas a day and was shut in.

MISSISSIPPI

• Humble Oil and Refining Company has completed its No. 1 Sandy Hook Gas Unit 24 for a new oil discovery in the Sandy Hook field, Marion County. Well was completed flowing at the rate of 105 bbl of oil per day through ⅛-in. choke plus 36 per cent salt water. Tubing pressure was 750 lb, gravity of oil 20.6 deg, and gas-oil ratio 360 to 1.

• In Adams County, Magnolia has completed its No. B-3 Tyer Swayze Unit in the Kingston field. Well flowed at the rate of 136 bbl of oil per day through ⅛-in. choke. Completion was from casing perforations 6602-16 ft opposite the Harman sand of the Wilcox group. Tubing pressure was 390 lb, gas-oil ratio 150 to 1 and gravity of oil 43.

OKLAHOMA

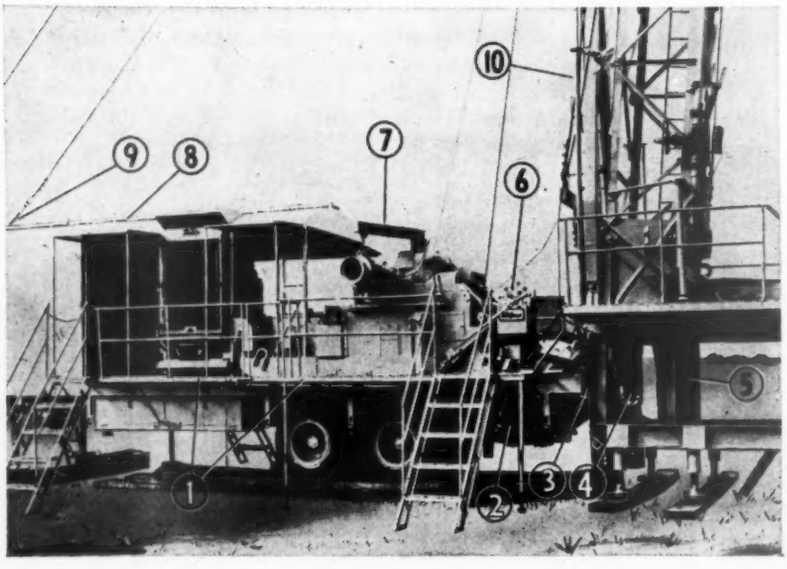
• Completion of one of the best producers in East Spring Valley field, Garfield County, Oklahoma, has been announced by J. A. True, president of Sterling Oil of Oklahoma, Inc. The new well is the firm's No. 2 Siegle, drilled into second Wilcox at 6062 ft to produce 60 bbl daily. Higher in the hole, the Marshall zone showed for production, and the Viola section, a new zone for the field, also carried saturation. Main pay in the well, a dual completion, is Mississippi lime where pipe was perforated from 5544 to 5564 ft to produce 7,900,000 cu ft of gas with 105 bbl of distillate per day. The Mississippi showed 80 ft of saturated porosity, only 20 ft being opened at this time.

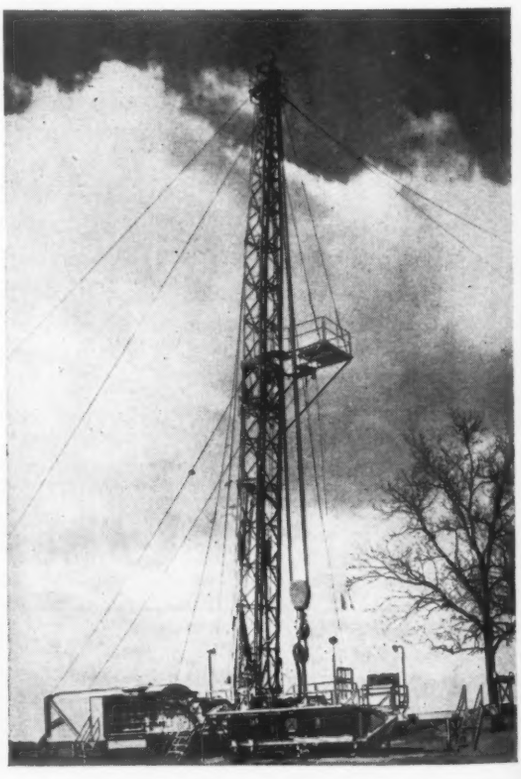
• Shell Oil Company's No. 2 Jones in Beckham County has been completed flowing 453 bbl of 60.6 gravity distillate in 24 hours through a 22/64-in. choke. The well was plugged back to 10,253 ft and given a gas-oil ratio of 9648 to 1 Production was from perforations 9873 to 9924 ft.

• The North Orlando pool of Noble County has its third productive zone. Newt Barrett, Grady Musgrove, and Midwest Oil Company opened production in the Skinner sand at their No. 1 Steiner. On a 60-min drillstem test gas was obtained in 10 min gaging 250,000 cu ft per day, and 390 ft of free oil and 30 ft of oil-cut mud were recovered. Other zones in this pool are Perry gas and Wilcox sand.

• Continental Oil and Shell Oil Companies' No. 4 Jay in Beckham County flowed 475 bbl of distillate in 24 hours through 22/64-in. choke. From a plugged back depth of 10,086 ft oil of 66.1 gravity was recovered with a gas-oil ratio of 3803 to 1. Production was made from perforations 9811 to 9856 ft.

C-B Drilling Company's new rig for Gulf Coast operations can be in service within two hours after arrival. The only setting up required is leveling jacks after the two trailers are joined, raising mast, and adjustment of guy system. Some of the major features on the drawworks trailer are numbered: (1) folding walkways; (2) pump for blowout preventers; (3) guide key for hooking trailers together; (4) swivel for mud line; (5) removable bolster beam and center support; (6) control panel; (7) pivot arm for Cathead; (8) toolhouse; (9) guy ties on toolhouse; and (10) mast trailer. The rig was equipped by Wilson Manufacturing Co.





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Exploration Activities

ALASKA

• Negotiations, which have been going on for some time, have now resulted in a general agreement between Phillips Petroleum Company and Kerr-McGee Oil Industries for the development of the Katalla-Yakataga area of Alaska. In this announcement, K. S. Adams, chairman, and Paul Endacott, president, of Phillips, also said that the operation of the properties will remain in Phillips, and Kerr-McGee will do the drilling and will take a one-half interest in the venture. After the agreement to share on interest in the project is written and executed it will be submitted to the Department of Interior for its approval. Kerr-McGee is a drilling contractor with equipment necessary to carry on drilling in remote areas such as this.

OKLAHOMA

• A trio of independent oil operators who drilled a wildcat well in the heart of a dry hole area in Logan County, have a new oil field as proof of their confidence.

Macmillan Petroleum Corporation of Los Angeles, in partnership with Blackwood and Nichols, Oklahoma City, and Richard S. Rheem of Los Angeles, announced completion of the discovery well, No. 1 Krout, with an estimated production of 52 bbl of 42 gravity oil per hour through a 32/64-in. choke, from perforated interval 6478-88 and 6508-38 ft opposite Second Wilcox Sandstone. Productive Second Wilcox pay interval approximates 150 ft.

Electric logs, core and drill stem test data indicate the presence of five additional potentially productive zones; three in the Pennsylvanian, and two in the Simpson. Most important of these is in the Simpson Dolomite where two drill stem tests resulted in gas flows estimated at 15,000,000 cu ft per day with a spray of distillate. Productive interval in this zone is indicated to be 100 ft.

Discovery represents a new addition to the chain of fields which comprise the Nemaha Buried Ridge of Central Oklahoma and Kansas. These Nemaha Ridge structures, although disconnected, are similar in shape and geologic history, and have been among the most prolific oil producers in the Mid-Continent area. Oklahoma records indicate the Wilcox zone is capable of producing from 600 to 1000 bbl per acre ft. Production allowable is 300 bbl daily or less.

Krout No. 1 drilled from Pennsylvanian strata into Sylvan Shale to establish the presence of a sharp elongated faulted anticline, similar to the Crescent anticline 6 miles to the North, which has produced 23,500,000 bbl of oil since its discovery in 1935 and is still producing approximately 600 bbl of oil per day. Location for Krout No. 1 was made in 1952 following seismic work by William Ross Cobeen and associates.

• Vickers Petroleum Company of Wichita, Kansas, announced completion of its Phipps No. 1 well in Carter County, Oklahoma. Total depths of the new Vickers well ran 4985 ft. The Morris zone was encountered at 4881 ft and a drillstem test run from 4916 to 4985 feet recovered 651 ft of fluid, of which 527 ft was oil and 124 ft mud.

Perforations were 4926 to 4941 ft and 4919 to 4935 ft. Pipe was set at 4985 ft. The new well is pumping 240 bbl of oil per day. Sandfrac treatment of 4000 gal was given and a swab test recovered 42 bbl of oil per hour before setting pumping unit and rods.

• Seminole County has a new oil well reported flowing 1440 bbl of oil per day. It is Powell Briscoe's No. 2 Kemp, which was drilled to a total depth of 2840 ft. Five and one-half inch casing was set at this depth, from which the 1440 bbl of oil per day flowed for two hours through casing.

Macmillan No. 1 Krout, Logan County, Oklahoma, is discovery in dry hole area.

CALIFORNIA

• Signal Oil and Gas Company is presently rigging up to drill a well in the East Los Angeles, California, area to be known as "Signal-C.M.D." No. 1. It is planned to carry the well to an approximate depth of 9100 ft, unless commercial production is obtained at a shallower depth.

KANSAS

• W. J. Coppinger's No. 1 Riney in Pratt County was given a potential of 1052 bbl of oil daily from the Lansing-Kansas City at 4055 to 4059 ft.

• Also in Pratt County, Coppinger has opened the Pratt field at its No. 1 Fitzsimmons. The well, drilled to 4063 ft, was given a potential of 1052 bbl of oil.

• Cities Service Oil Company has completed a new oil discovery in Pawnee County—its No. 1 Smith. The new well flowed 2822 bbl of 30-gravity crude daily on an initial production test from the Arbuckle dolomite at 3958 ft.

NEW MEXICO

• Natural gas has been found outside the limits of the Four Corners area, San Juan Basin, New Mexico. Southern Union Gas Company's No. 1-A Navajo tested 13,900,000 cu ft a day through tubing, and according to Van Thompson, manager of the exploration department of the company, it will run over 40,000,000 cu ft through casing. Well is not far from the point where New Mexico, Colorado, Utah, and Arizona meet. It is in an area previously thought dry—8 or 10 dry holes were drilled.

• In Northwest Lea County, Skelly Oil Company has completed its No. 1-S Mexico for 533 bbl of oil per day through 15/64-in. choke from 8600-36 ft. Gas-oil ratio was 1190 to 1, and 500 gal of acid were used.

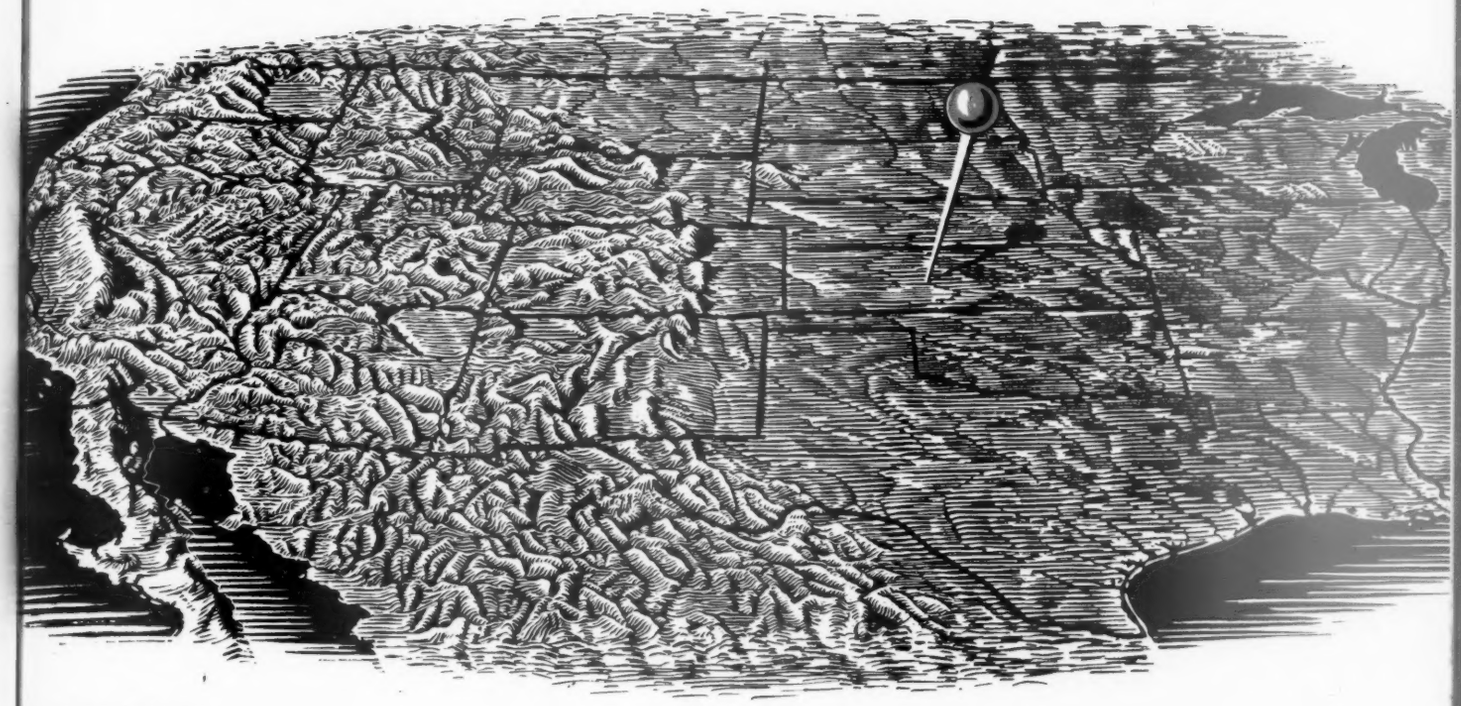
• Lawton Oil Corporation is completing its No. 1-L State also in Lea County. Well is completing through perforations at 11,430-88 ft where a preliminary drillstem test got an oil flow in 40 min. It flowed 7 bbl of oil per hour for 7 hr with gas-oil ratio 1805-1.

• Continental Oil Company has indications of an important oil discovery in Lea County. Test is the company's Anderson Ranch Block Unit No. 1. The well was tested for 11 hours at 13,408 ft in the Devonian lime, and flowed 54 gravity oil at a daily rate of more than 800 bbl of oil through a 1-in. choke. Gas volume was estimated at 613,000 cu ft per day.

NORTH DAKOTA

• The M. B. Rudman-New Concord Corporation R. Jensen No. 1 well in Mountrail County, North Dakota, was reported making 54½ bbl an hour on a ½-in. choke, over a three hour period, an estimated daily flow of 2576 bbl. Tubing pressure was 1400 lb with gravity at 43.5. The well was perforated at an interval from 8187 to 8217 with four shots per ft, 1000 gal of mud acid used.

Rudman, the first independent oil operator to bring in a producing well in North Dakota, the Math Iverson No. 1 in Williams County, and the New Concord Corporation of Toronto began a three-year drilling program on Williston Basin properties last November.



What's so different about Great Bend, Kansas?

That single pin is symbolic of specific problems facing a core analyst in the Great Bend area. Actually the pin could have been spotted at Calgary, or Abilene, or Tyler, or Lafayette — or at any one of Core Lab's twenty-nine field offices. The point is — wherever drilling is in progress the "pay-off" characteristics of oil, gas, and water-bearing formations vary from area to area, basin to basin, county to county, and in large fields, even from well to well.

True, each of our permanent and portable units is equipped with standard core analysis equipment. True, every man who analyzes core for Core Lab follows modern laboratory procedures. Certainly we use Core Lab-developed sets of "average" data for specific areas. So do our contemporaries.

Then what is it that makes Core Lab's core analyses more reliable, more comprehensive? It is *seventeen years of Experience* which we are privileged to draw upon — *Experience* that, under certain conditions, may even defy routine mechanically-procured information.

It is seventeen years of core analysis work, associated with the discovery and production of more than 700 fields, which affords Core Lab the ability to anticipate, to recognize, and to interpret accurately every existing aspect of reservoir behavior.

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XUM

Exploration Activities

LOUISIANA

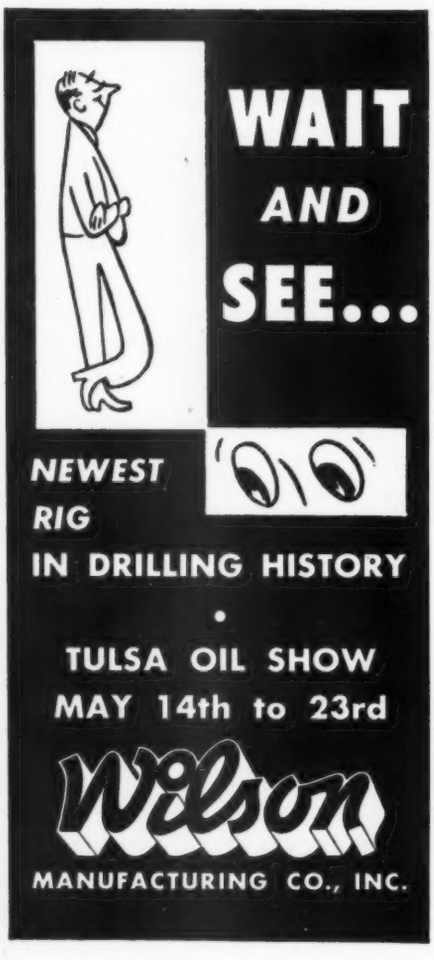
• California Company has brought in a new well in Rapides Parish, on properties owned by Long-Bell Lumber Company. The new well had an initial flow of 257 bbl of oil a day, from a depth of 9413 to 9426 ft.

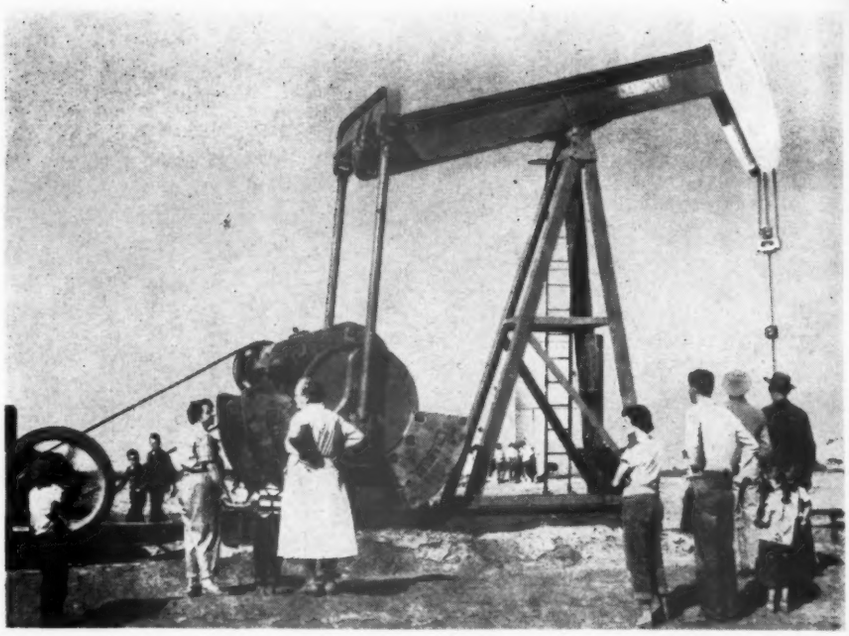
• What is believed to be a major oil discovery is being completed in St. Charles Parish by Pan American Production Company and Pan American Gas Company. The well is the Simoneaux No. 1, which was drilled to 11,234 ft and plugged back to 10,476 ft. On a preliminary test the well flowed 300 bbl of 37-gravity oil through a 12/64-in. choke in 24 hours. Gas oil ratio was 1000 to 1. What may prove to be significant, company officials state, is that the new well has not penetrated sands found productive in the Paradise field, about six miles west of the new well.

• In Bossier Parish, Pan American is completing a new gas distillate producing area well. It is the L. V. Hunt No. 1, which flowed 2000 ft of water cushion in 8 min followed by gas and distillate with 2000 lb of surface pressure. The Bodcaw sand was cored from 8318 to 8336 ft.

UTAH

• Carter Oil Company has reported completion of its No. 1 Floria Bamburger in the Walker Hollow area of Unitah County. Flow was reported at 3,404,000 cu ft of gas daily. Carter also completed its No. 2 Bamburger for a pump gage of 89 bbl of oil per day.





Interested Citizens inspect pumping unit on Vaughey and Vaughey's State No. 1 during Oil Day Celebration in Kimball County, Nebraska. This is the first producing well discovered on school lands owned by the State of Nebraska, which will receive one-eighth of the royalties. Well is reported capable of producing a 1000 bbl a day, but at present this and other Kimball County wells are restricted to 110 bbl a day.

MONTANA

• Shell Oil Company reported that it has recovered 4400 ft of 32.5 gravity oil from its Cabin Creek wildcat, Unit 22-23, Fallon County, Montana. Test was made in the Mississippian at 7310-7360 ft. *Petroleum Information* reports that this is the first well to find significant amount of oil from the Madison along the Baker-Glendive anticline, extending more than 75 miles southeast-northwest along the west flank of the Williston Basin. It apparently establishes the second Madison producing field in the Montana portion of the basin, the report continued.

GEORGIA

• Two paleozoic wildcats have been announced in Walker County, northwestern part of the state. H. L. Chapman will drill the No. 1 Mrs. J. H. Fitzpatrick et al. Proposed depth is 2000 ft. In the same area, T. P. Posey will drill the No. 1 Vernon close to the same depth.

TEXAS

• Cities Service Oil Company has a gas discovery at its Dorothy Bounds No. 1 test in Limestone County, Texas, five miles southeast of Mexia. The well was completed for an open flow of 13,000,000 cu ft of gas daily, with distillate production at the rate of 2.14 bbl per 1,000,000 cu ft of gas. Test was drilled to a total depth of 5953 ft, plugged back to 4313 ft and is producing from perforations in the Woodbine sandstone between 4217-4224 and 4227-4232 ft.

• The Texas Company has completed an oil discovery in Reagan County, West Texas. It is the company's State of Texas A.C. No. 1, rank wildcat, which flowed 288 bbl of 51.7 gravity oil per day through 18/64-in. choke. Ellenburger lime discovery was completed from perforations 8410-9500 ft. Nearest production is the Old Big Lake field, about nine miles east.

• A good oil well is being completed in Mitchell County, in West Texas, at Sun Oil Company's No. 1 McCabe, Pennsylvanian discovery. The well flowed 156 bbl of oil in 24 hours, from perforations at 5890-5916 ft. Gas-oil ratio was 2215.

• A wildcat flowing oil from the Strawn lime from 9771 to 9850 ft, has been brought in by The Texas Company in Upton County. Gas surfaced in 5 min at the rate of 2,000,000 to 3,000,000 cu ft per day, and the well made 14.49 bbl of oil in 52 min. No water was found. Hole has been bottomed at 9910 ft.

• Humble Oil and Refining has completed a deep well in Andrews County at its 1-Q University. The Devonian discovery flowed at the rate of 418 bbl of 44 gravity oil per day on a 24-hr test. Production is from 12,505-31 ft.

MISSISSIPPI

• Sinclair Oil and Gas Company will drill the No. 1 R. M. Epperson in Chickasaw County, northeastern Mississippi. Test is scheduled to go to 3500 ft, 50 ft into the Tuscumbia lime.

MEXICO

• Gulf Sulphur Corporation has reported discovery of a rich sulfur deposit on the Isthmus of Tehuantepec in Mexico. Well is the company's No. 48, one of 8 wells completed in the limestone area.

SOUTH DAKOTA

• Youngblood and Youngblood will drill a rank wildcat in Dewey County, in the northcentral part of the state. It will be the company's No. 1 Genevieve J. Garvin, with Trident Drilling Company as contractor.

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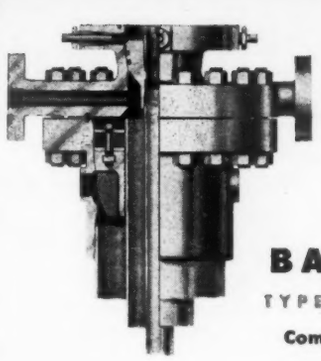
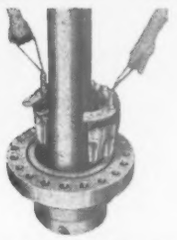
provides 3 basic types of units to simplify your well-head needs

For many years Baash-Ross has been a leader in the development of more compact, more efficient Well Head Equipment. And to meet the varied requirements of present-day operations, Baash-Ross now offers *three* basic types of Head Assemblies—each offering certain vital advantages to save time, space, and money on your development programs . . .





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TYPE "UPS" HEADS

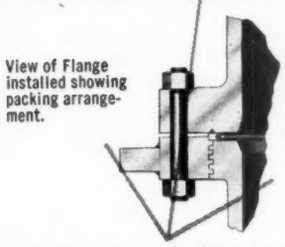
Combine Pack-Off And Slips In One Unit

Type "UPS" Heads—a new Baash-Ross development—have the Packing Element and Slips unitized into a *single* hinged assembly that simply w-r-a-p-s around the casing and locks in place with one bolt. As the weight of the casing is placed on the slips, they *automatically* equalize themselves within the bowl to assure exact centering of the casing as well as a uniform grip around the *entire circumference* of the pipe. A few quick turns of a wrench then expands the packing element for a pressure-tight seal.

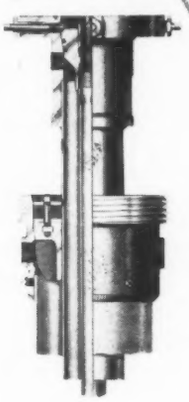
"UPS" ADVANTAGES INCLUDE . . . (1) No space wasted by threads, grooves or other packer-retaining devices—therefore overall height is reduced to a minimum . . . (2) Elimination of threads, grooves, etc., means a smooth bowl—nothing to become damaged during drilling operations, no need for protective sleeves . . . (3) Since all the slip segments are unitized together, none can set higher or lower than the rest—no risk of crimping the casing, no danger of an unequal grip that may fail in service . . . (4) Slips are set and packing is tightened around casing without stripping and without first cutting the casing. Simplifies installation—saves time!

"UPS" Heads also incorporate the unique Baash-Ross weld-testing feature which permits simultaneously testing the pressure-tightness of *both* casing welds with a gauge and hand pump as part of the installation procedure—or any time later. Any leaks discovered during the life of the well can be quickly sealed off by injecting plastic pack material.

"UPS" Equipment is available in a complete range of sizes . . . for threading or welding to the casing . . . with or without Bases . . . and for use with over a dozen different Tubing Heads Suspensions and Hook-Ups. *It is the ideal solution for a wide range of requirements on medium and low-pressure wells!*



View of Flange installed showing packing arrangement.



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TYPE "UPS-DF" HEADS

Offer "UPS" Advantages *Plus Demountable Flanges*

Type "UPS-DF" Heads combine all the "UPS" advantages with an additional important feature—*Demountable Flanges that can be salvaged after the drilling operations for use on other installations.*

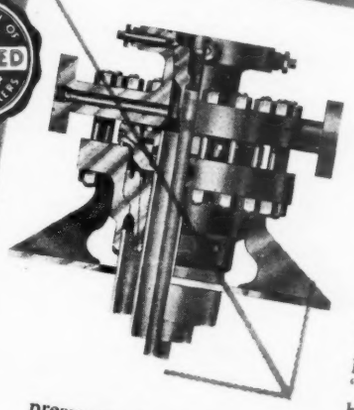
The body, packing and slips of this design are the same as standard "UPS" Heads to provide all the important "UPS" advantages outlined at left. However, the flange is attached to the main body by means of a square thread so that it can be readily removed when drilling operations are completed.

During drilling, the flange is installed on the Head to provide means for attaching standard pressure control. A unique packing arrangement—having important advantages over the conventional ring-groove design—prevents leakage between the flanges and is so placed that the square thread is not exposed to casing pressure.

After drilling is completed, the pressure control equipment is removed and the flange is unscrewed from the Head—an operation simplified by the easy make-and-break properties of the square thread. The flange, ring bolts and packing can then be used repeatedly on other wells, thus effecting important economies on multiple installations.

Available in a complete range of sizes and designs, Type "UPS-DF" equipment is the latest in a long string of Baash-Ross Landing and Casing Head advancements. *Be sure to investigate the economies this equipment can make for you!*

ASSOCIATION OF WELL HEAD EQUIPMENT MANUFACTURERS CERTIFIED



BAASH-ROSS
TYPE "X" HEADS

Provide Vital Advantages for High-Pressure Installations.

Developed several years ago to give new efficiencies on high-pressure wells, Type "X" equipment has been widely used on wells of all depths and pressures. It offers unusual simplicity, compactness and adaptability to different installation requirements, and the heavy-duty pack-off provides a dependable seal against the highest well pressures. The pack-off is made in a separate unit that fits between flanges—a pressure-tight seal being formed around the casing by a double-element Packing Assembly tightened by stud bolts.

TYPE "X" ADVANTAGES INCLUDE . . . (1) No grooves or threads in bowl to become damaged during drilling operations . . . (2) One-piece Packing Assembly mounts between flanges for maximum space saving . . . (3) Unitized Slips assure uniform slip pressure . . . (4) Packing Assembly and casing weld are so designed that seal around casing can be checked at any time during life of the well, and repaired with plastic material *without even breaking connections* . . . (5) Series ratings and flange sizes can be easily changed in the Head.

Type "X" Heads are available in a complete range of sizes, pressures and variations to meet every well requirement!

Baash-Ross Well Head Equipment is available through leading supply stores.

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XUM

Running Tour With Men in the Industry

▸ **Roy L. Lay,** of Houston, Texas, and **Dr. Karl Dyk,** of Tulsa, Oklahoma, have been elected president and vice president, respectively, of the Society of Exploration Geophysicists. Their election was announced by Curtis H. Johnson of Los Angeles, retiring president.

Johnson also announced that **Bart W. Sorge,** of San Gabriel, California, has been named secretary-treasurer of the organization, and **Milton B. Dobrin,** Dallas, is the Society's new editor. Dobrin's term is for two years, the other officers for one.

Lay, new president, is manager of the geophysical division of The Texas Company in Houston. He joined the company in 1932, and has held his present position with the company since April 1, 1950. Lay is a graduate of Rice Institute.

Dr. Dyk is chief geophysicist of Stanolind Oil and Gas Company in Tulsa. He has been with the company since 1935, was made geophysical supervisor at Tulsa, and in 1948, became chief geophysicist. Dyk is a graduate of the University of California.

Sorge is vice president of United Geophysical Company at San Gabriel. He holds BA and MA degrees in physics from UCLA and has been with United since 1938. Dr. Dobrin, the S.E.G.'s new editor, is senior research technologist at Magnolia Petroleum Company's Field Research Laboratories in Dallas, having joined the company in 1949. He holds degrees from Massachusetts Institute of Technology, University of Pittsburgh, and Columbia University.

▸ **L. A. Martin** was recently elected vice president and chief geophysicist of United Geophysical Company. He has been with United since 1946 and has served as manager in Venezuela and manager of foreign operations.

▸ **Louis F. Davis,** Atlantic Refining Company, Dallas, Texas, is the newly-elected chairman for American Petroleum Institute's Southwestern Production Division. He replaces **E. N. Van Duzee,** New Orleans, Louisiana.

APA's Southwestern Production Division new officers are: W. B. Duncan, J. D. Exner, Raymond E. Meleton, Louis F. Davis, R. M. Freeman, C. L. Bramlett, and Ray Elner.

The Dallas man and eleven vice chairmen to function in Texas, Louisiana, Alabama, Mississippi, New Mexico, and Arkansas were elected recently at closing sessions of the API producers' meeting in Fort Worth at the Hotel Hilton.

Vice chairmen include: **Don Miller,** Phillips Petroleum, West Texas; **C. L. Bramlett,** Halliburton Oil Well Cementing, Southwest Texas; **T. J. Fuson,** Humble Oil and Refining, Texas Gulf Coast; **J. D. Exner,** Humble Oil and Refining, North Texas; **W. S. Crake,** Shell Oil, East Texas; **Ray Elner,** Kobe, Inc., Central Texas; **R. K. Guthrie,** Seeligson Engineering, Balcones area; **Weldon Ramseur,** Gulf Refining, Alabama-Mississippi; **Raymond L. Meleton,** Arkansas Fuel Oil, Arkansas-Louisiana; **John E. Shannon,** Magnolia Petroleum, Southern Louisiana; **Dan Bodie,** Cities Service, Southeast New Mexico.

Elected secretary-treasurer of the district was **George Gray,** Baroid Sales Division, National Lead Company. **W. B. Duncan,** Houston Oil Company of Texas, Houston, was named chairman of the advisory committee.

▸ **Felix A. Runion,** Texas geologist and petroleum consultant, has joined the staff of The Rice Institute to manage its oil interests and to assist in obtaining new oil investments. Runion is a partner in the firm of Smiser and Runion, petroleum geologists and engineers in Houston, Texas. He is a graduate of Rice and formerly was with Humble Oil and Refining Company for a period of 14 years. When Runion resigned in 1944 to join the firm of Boyce and Smiser, petroleum consultants, he was head of the evaluation section.

▸ **Wallace L. Matjasic,** Honolulu Oil Corporation, was named as Los Angeles district representative for the American Association of Petroleum Geologists. Other Los Angeles representatives include: Harold Rader, Standard Oil of California, and Benjamin C. Lupton, General Petroleum Corporation.

Representative from Santa Barbara Coastal district is Richard C. Shelton, Ohio Oil. Bakersfield, San Joaquin Valley representative include: Stanley A. Carlson, Richfield Oil Corporation, and R. L. Hewitt, Trico Oil and Gas Company.

▸ **Dr. Robert C. Spivey** has joined Shell Oil Company's Pacific Coast area exploration staff in Los Angeles as senior geologist.

Spivey joined Shell in Texas in 1940. Prior to that he served for two years as a member of the faculty at the University of Iowa. He obtained his degree in geology from Texas Technological College, and his Ph.D. degree from the University of Iowa. Spivey came to the Pacific Coast from the company's Midland area in Texas.

Bill Wilson, Web Wilson Oil Tools, retiring president of Los Angeles Chapter of Nomads, receives a gavel as token of appreciation from Earle Boggess of Baker Oil Tools, Inc., retiring senior regent, at the Fourteenth Inaugural Ball of the chapter. At right are new officers of the Los Angeles chapter. Bill Wilson, junior regent; Jerry Engstrand, Grant Oil Tool, senior regent; Joe Schlarb, Chiksan, sergeant-at-arms; Jim Hughes, Lane-Wells, president; John Flanagan, Johnston Testers, vice president; Bill Sargent, Sargent Engineering, secretary; Bob Craig, National Supply, treasurer; Wally Sawdon, Technical Information Service, executive secretary. Not shown: Vern Mitchell, Security Engineering, assistant secretary; Leo Cypher, Baash-Ross Tool, assistant treasurer, and Ox Morgan, Oil Well Manufacturing Company, deputy sergeant-at-arms. Event was held in the Pacific Ballroom of the Hotel Statler in Los Angeles.

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NEW WAYS OF DOING THINGS

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**STANDARD CASING GLASS JET	7-1/8"	6-13/16"	6-1/8"	3-3/4"
3-1/2" O.D. *M-3 BURRLESS BULLET	9-1/2"	6-11/16"	4-11/16"	1-7/16"
**SUPER CASING GLASS JET	8-1/2"	8-1/8"	7-5/16"	4-3/4"
4-1/4" O.D. *M-3 BURRLESS BULLET	10-3/4"	8-1/16"	6-1/16"	1-9/16"
**SUPER FORMATION GLASS JET	9-3/4"	9-3/16"	8-1/4"	5-3/4"
4-3/4" O.D. *M-3 BURRLESS BULLET	11-7/8"	9-1/16"	6-13/16"	1-5/8"

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Gentlemen:
Please send me my free copy of "How To Get More Oil" by return mail.

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ADDRESS_____ CITY_____ STATE_____

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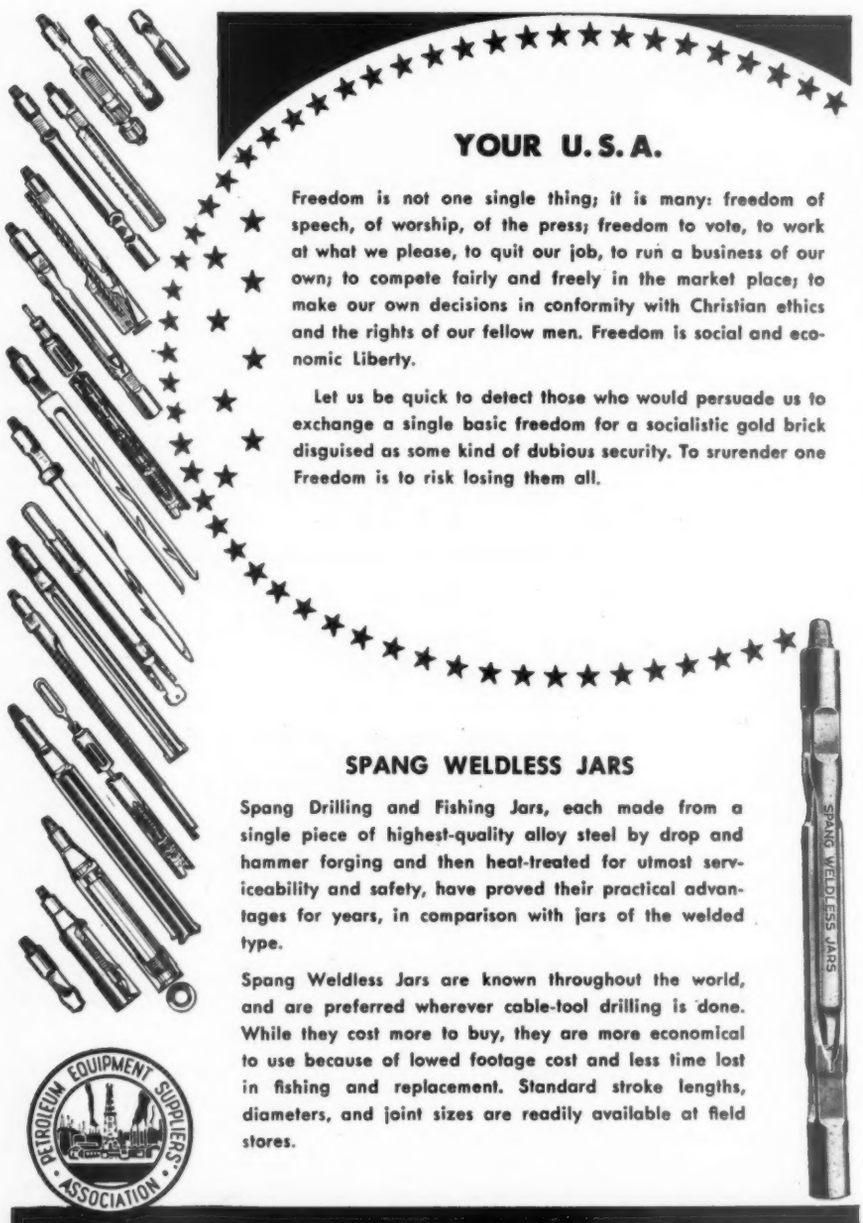
XUM

Running Tour

Hartley C. Gleason has been employed by The Crusader Corporation, Crusader Building, Denver, Colorado, as manager of production and drilling replacing the late John W. Denny of Casper who died January 19. Gleason resigned his position on February 14, 1953, as production engineer of the British American Oil Company in charge of the Rocky Mountain district. He had been associated with that firm since 1947. In his position with The Crusader Corporation, Gleason will not only have charge of the present production and drilling program of that company but will also have charge of the production and drilling activities of Morton Oil Company, a subsidiary of The Crusader Corporation.

Dallas-Fort Worth Nomads and guests shown at formal dinner dance are: Beginning center foreground and reading clockwise: Mrs. Alma Brewer, M. H. Grove, Grove Regulator Company, Oakland, California; Miss Nancy Grove; Bruce Whitson; Mr. and Mrs. J. W. Collins, Grove Regulator; Miss Anita Price, secretary to Grove; Mrs. M. H. Grove, and Ed Lorain, Cameron Iron Works.


YOUR U.S.A.
Freedom is not one single thing; it is many: freedom of speech, of worship, of the press; freedom to vote, to work at what we please, to quit our job, to run a business of our own; to compete fairly and freely in the market place; to make our own decisions in conformity with Christian ethics and the rights of our fellow men. Freedom is social and economic Liberty.
Let us be quick to detect those who would persuade us to exchange a single basic freedom for a socialistic gold brick disguised as some kind of dubious security. To srurender one Freedom is to risk losing them all.
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Spang Drilling and Fishing Jars, each made from a single piece of highest-quality alloy steel by drop and hammer forging and then heat-treated for utmost serviceability and safety, have proved their practical advantages for years, in comparison with jars of the welded type.
Spang Weldless Jars are known throughout the world, and are preferred wherever cable-tool drilling is done. While they cost more to buy, they are more economical to use because of lowed footage cost and less time lost in fishing and replacement. Standard stroke lengths, diameters, and joint sizes are readily available at field stores.
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SHOT BLAST HOLES • PROSPECT DRILLING
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George S. Buchanan has joined Husky Oil Company, Cody, Wyoming, as a director and vice president in charge of exploration on March 1, 1953. Buchanan has resigned as vice president in charge of land and exploration for the Sohio Petroleum Company. He is a graduate of the University of Michigan. Directing land and exploration activities for Sohio Petroleum in the United States and Canada, Buchanan also served Sohio as operator's representative in Canada for a group of six associated companies. Prior to joining Sohio in 1945, he was president of the Adams Louisiana Company and the Yegua Corporation. The Adams Louisiana Company was purchased by Sohio.

W. E. (Gene) Powell had joined Husky's Canadian subsidiary, Husky Oil and Refining Ltd., as manager of exploration. Powell was formerly manager of Canadian operations for the Seaboard-Honolulu-Sunray oil group in Canada and prior to that was with the Barnsdall Oil Company for 22 years.

R. L. Wales has been promoted to assistant division manager of the Oklahoma division of the producing department, The Texas Company. Now assistant to manager of the geophysical division, in charge of geophysical operations in Canada, Wales has been in Calgary, Alberta, Canada, and in his new assignment will have headquarters in Tulsa, Oklahoma. He will replace **Harvey Cash** who has been transferred to the company's foreign operations department in New York.

Wales is a graduate of the University of Saskatchewan. He joined Texaco as assistant recorder in 1936.

Leon Jacolev has resigned from The Texas Company to devote himself to consulting practice at 92 Gordonhurst Avenue, Montclair, New Jersey. He specializes in various phases of synthesis gas generation and utilization, with emphasis on process and economic evaluations.

Jacolev, who is also the owner and technical director of Associated Technical Services, is currently expanding his activities to provide translations and literature research services from 18 languages (including Russian and Japanese) covering physical sciences, chemical, and related technologies.

Herman Aweas, associated with Helmerich and Payne, Inc., for 19 years, has been elected vice president in charge of drilling.

Harry Saye, associated with Helmerich and Payne, for 17 years, has been elected vice president in charge of production.

Dee A. Sikes, associated with Helmerich and Payne, for four years, have been elected vice president. Sikes will be in charge of drilling contracts and public relations for the company.

Harold E. Tips, associated with Helmerich and Payne, for nine years, has been elected vice president in charge of land department.

Erik K. Waering, chief geologist, associated with Helmerich and Payne, for seven years, has been elected vice president in charge of exploration.

Jay C. McWilliams, North Louisiana district production superintendent for Continental Oil Company, has been appointed East Texas district production superintendent.

He succeeds **A. A. Anders,** who was recently promoted to West Texas-New Mexico division production superintendent and transferred to Conoco offices at Midland, Texas. It was announced at the same time that **Kenneth M. Hammond,** Houston, Texas, a member of Continental's southern region production staff will succeed McWilliams as North Louisiana district production superintendent at Ville Platte.

McWilliams joined Conoco in 1937. He was promoted to North Louisiana production superintendent in 1950.

Hammond joined Continental in 1929. He was Wyoming district production superintendent before transferring to Houston in 1950.

Anders succeeds **Harry Miller,** who has been transferred to Oklahoma City and promoted to assistant production manager of Conoco's central region. Anders joined Continental in 1931. He was named East Texas district production superintendent in 1947.

M. M. Keeble has been transferred by Magnolia Petroleum Company as district superintendent of the Kermit producing district to a newly created district in the Snyder, Texas, area to be known as the Sacroc Two district.

J. M. McLaughlin has been transferred from assistant district superintendent of the Brownfield producing district to the Sacroc Two district at Snyder, as assistant district superintendent.

E. G. Blundell has been promoted from assistant district superintendent of the Kermit district to district superintendent of the same district.

Robert W. Lewis, Jr., formerly assistant division petroleum engineer at Midland, Texas, has been made assistant district superintendent of the Kermit producing district.

J. H. Brewer has been promoted from producing foreman in the Pegasus producing district, to assistant producing superintendent of the Brownfield district.

Hillard Greenwood, production gang pusher in Magnolia Petroleum's Duncan district, has been promoted to assistant foreman in the same district.

Initiated into Dallas-Fort Worth Chapter of Nomads recently were: Jack Norton, L. B. Meadows, Bill Berhorst, and Jack Magoffin of the companies indicated on the placards.

Cyrus O. Turner, assistant foreman at Duncan, has been promoted to production foreman and transferred to the Kermit producing district.

Marion W. Lovelace, assistant foreman in Magnolia's Pegasus district in West Texas, has been promoted to production foreman in the same district.

Albert W. Shaw, Jr., petroleum engineering assistant in the Kermit district, has been promoted to assistant production foreman and transferred to the company's Pegasus district.

Ernest B. Etheridge, assistant foreman in the Shreveport, Louisiana, producing district, has been promoted to production foreman in the same district.

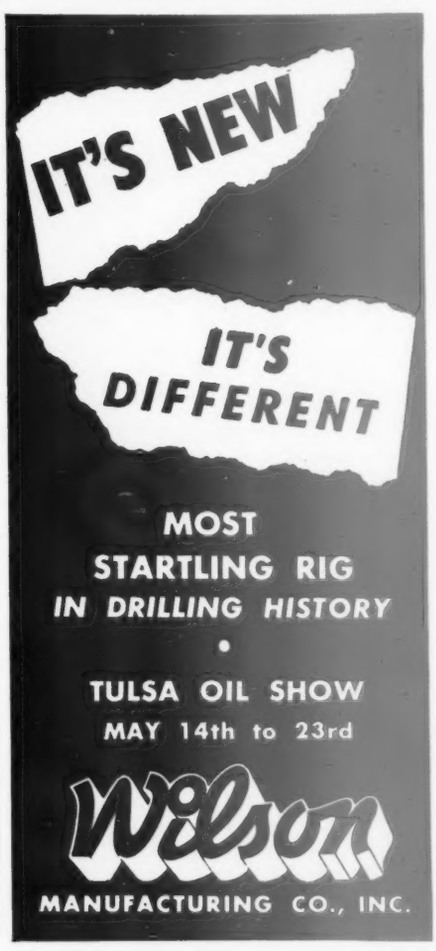
Lavis C. Chance has been promoted from gang pusher in the Rusk producing district in East Texas to assistant foreman in the Shreveport district.

Benjamin F. Dufield, Jr., production pumper in the Louisiana-Gulf producing district, has been promoted to assistant foreman in the same district.

W. P. Orr, Humble Oil and Refining Company senior petroleum engineer, Hawkins district, was promoted to district petroleum engineer at the Palestine district, East Texas division.

C. S. Yust, tool pusher, California area, was transferred to the Lovell Lake district, Gulf Coast division.

McIver Hay of the North Crowley district and **Leroy Harper,** Potash district, Louisiana division, both of whom have been serving temporarily as tool pusher, were promoted permanently.



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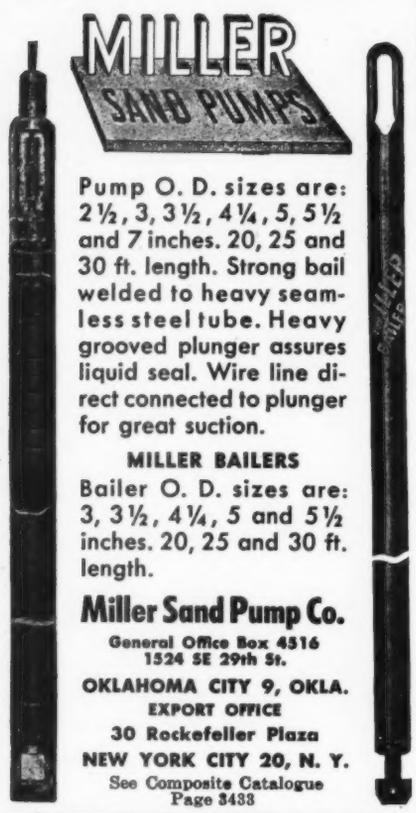

Pump O. D. sizes are: 2½, 3, 3½, 4¼, 5, 5½ and 7 inches. 20, 25 and 30 ft. length. Strong bail welded to heavy seamless steel tube. Heavy grooved plunger assures liquid seal. Wire line direct connected to plunger for great suction.

MILLER BAILERS

Bailer O. D. sizes are: 3, 3½, 4¼, 5 and 5½ inches. 20, 25 and 30 ft. length.

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See Composite Catalogue Page 3433

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TULSA OIL SHOW
MAY 14th to 23rd

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MANUFACTURING CO., INC.

Running Tour

▸ **J. R. Vandever,** formerly exploitation department superintendent, Sunray Oil Corporation, has been named to a new post as manager of joint operations for Sunray. Vandever will be in charge of partnership operations, lessor relations, and contract obligations of the department. Vandever joined the Sunray organization in 1930, and served as division superintendent of the company's north and west Texas district before being transferred to the general offices in 1948.

John H. Douma and **C. J. Kerwin,** who formerly have been assistant general superintendents in the exploitation department, have been named southern division superintendent and northern division superintendent respectively. Douma has been associated with the company since 1938 as drilling and production engineer, staff engineer, and assistant superintendent of production. Kerwin joined the company in 1948, and his industry experience prior to that time was extensive.

Additional departmental personnel changes announced include the appointment of **M. S. Patton, Jr.,** to be development advisor of the department, and **J. F. Adkisson, Jr.,** to be technical advisor. Patton joined Sunray in 1948; Adkisson in 1940.

▸ **Frank M. Brewster, Jr.,** of Belmont Quadrangle Drilling Corporation, Bradford, Pennsylvania, has accepted appointment as a member of the Pennsylvania Grade Crude Oil Association's production research advisory technical committee.

The committee steers the association's research in production of petroleum by secondary recovery methods.

▸ **Floyd Brett** has been named general superintendent of production for Sinclair Oil and Gas Company. His headquarters will remain in Tulsa, Oklahoma, where he has been assistant general superintendent of production for the past two and one-half years.

A graduate of Oklahoma A & M College, Brett joined Sinclair upon graduation in 1929. He was appointed to his former position in 1950 and during the last half of 1951 was given a leave of absence to serve as assistant director of production of the Petroleum Administration for Defense in Washington.

▸ **Dr. J. Robert Berg,** associate professor of geology at the University of Wichita, has been named head of the geology department succeeding Dr. Walter Ver Wiebe.

Dr. Ver Wiebe, a veteran of 26 years on the staff, has relinquished the headship of the department due to a university policy, which provides for administrative retirement at age 65.

Dr. Ver Wiebe will continue his teaching duties on the university campus and devote more time to writing.

Dr. Berg joined the university geology staff in 1946 after serving as a Shell Oil Company geologist for two years. He was chemical engineer for the E. I du Pont Company for three years. Dr. Berg has also served as a petroleum consultant for the Brazilian government.

▸ **Dr. Robert W. Webb** has accepted the joint position of executive director of the American Geological Institute and executive secretary of the division of geology and geography of the National Research Council. Dr. Webb will be on leave of absence from his position as professor of geology, department of physical science, Santa Barbara College, University of California.

▸ **Eugene L. Earl** has been named vice president and manager for Louisiana exploration, Monterey Exploration Company, with headquarters in the Pere Marquette Building in New Orleans. Simultaneously, the company discloses that **R. E. Bounds** has been named Louisiana division land man.

Earl was formerly Gulf Coast division geologist for British-American Oil Producing Company. He is a graduate of the University of Texas in 1932. Bounds was formerly Louisiana district land man for the California Company. He was graduated from Louisiana State University.

▸ **W. L. McKinnon** has been named manager of the research laboratory in the recently reorganized exploration and production research division of Shell Development Company. Other appointments include: **C. H. Fay,** manager of the physical department; **W. R. Purcell,** manager of the chemical department, and **R. J. LeBlanc,** manager of the geological department.

▸ **Murray J. Wells,** division geologist for Cities Service Oil Company, at Casper, Wyoming, has been named division manager of exploration for the Northwest division with headquarters at Casper. The Northwest division includes the Northern Rocky Mountain, Williston Basin, and adjacent areas. In addition to his duties as manager of exploration Wells will continue to act as division geologist. **Walter W. Wittlinger** is division land man.

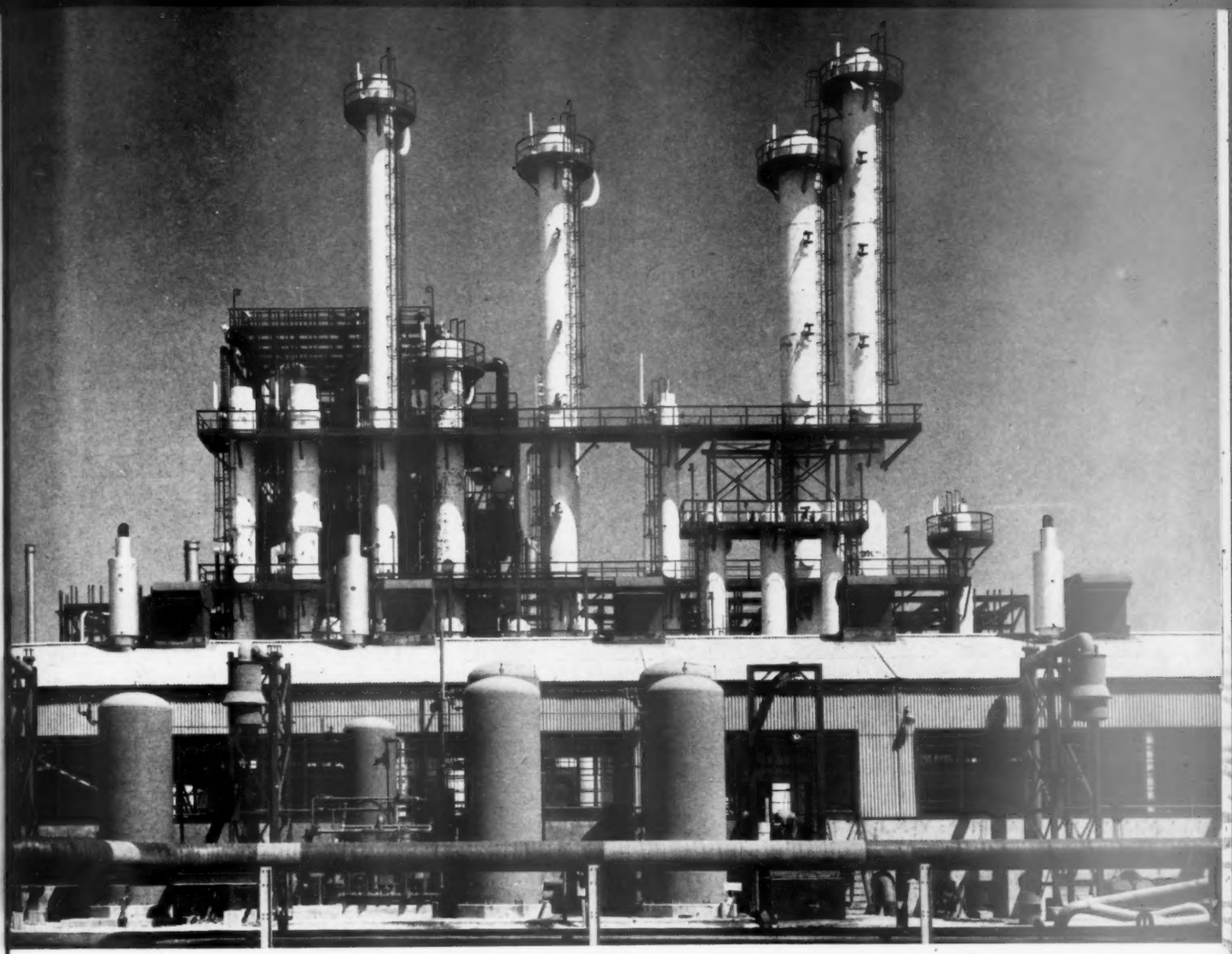
W. C. Koger has been named head of Cities Service Oil Company's oil production division corrosion and oil treating section. Koger will maintain his office at Great Bend, Kansas, for the present.

Koger was first employed by Cities Service in 1944, after graduating from the University of Arkansas. His first assignment was in the company's research laboratory at Okmulgee, Oklahoma.

▸ **R. M. Smith,** Los Angeles, California, assistant to Continental Oil Company's western regional geologist, has been promoted to director of training for the company's production department, with headquarters in Houston, Texas.

He succeeds **R. B. Sale,** who was recently promoted to director of executive development for Conoco.

Smith joined Continental in 1948 as a geologist at Los Angeles and two years later was promoted to assistant to the western regional geologist. Previously he was associated for 12 years with the Panhandle Eastern Pipe Line Company at Kansas City, Missouri. He was graduated from the Colorado School of Mines.



Courtesy — Dow Chemical

Fractionating equipment in the petrochemical field is designed and operated in a manner similar to the same types of equipment in petroleum refining.

P 759.6

Petrochemicals Expanding 14 Per Cent Annually

Industry produces 70 per cent of all U. S. organic chemicals; other chemicals grow only 10 per cent yearly, average U. S. industry only five per cent

JAMES H. BOYD and CLAUDE A. RACKUS

BROADLY speaking, petrochemicals can be considered as those chemicals that are manufactured from petroleum and natural gas hydrocarbons.

Petroleum and chemical industries have made notable achievements in the utilization of natural gas and petroleum hydrocarbons for the production of a vast number of chemicals, many in large volume. This use consumes only about one per cent of the petroleum and natural gas produced. These hydrocarbon raw materials are converted directly or through intermediates to synthetic rubbers, fibers, and detergents; to antifreezes, brake fluid, lubricating oil additives and antiknock agents; to chemical fertilizers, explosives, carbon black and a considerably wide range of industrial chemicals that include alcohols, ketones, aldehydes, and acids.

The long term outlook for the petrochemical industry is bright. The development of new products and of new applications for established products and the constantly improving technology of their production point toward an upward growth trend for the petrochemical industry.

The petrochemical industry has been growing more rapidly than the petroleum and natural gas industries (See Table 1).

In this country some important petro-

EXCLUSIVE

One of the earliest U. S. ventures in petrochemicals was carried out here in this concrete-wall protected, 3000 psig-reactor, where Esso synthesized alcohols from refinery olefins; now used to make octyl alcohols, used in plastics manufacture.

The Authors

J. H. Boyd C. A. Rackus

James H. Boyd needs no introduction to readers; an outstanding authority on petrochemicals, consultant to the industry on petrochemicals, synthetic rubber and hydrocarbons, he is known wherever these products are known or studied. Graduate of Kenyon College, D. Sc. from Massachusetts Institute Technology in chemical engineering, he had long years of first-hand experience in petroleum refining and chemicals with Atlantic Refining, du Pont, Phillips Petroleum (Hycar Chemical) companies from 1926 to 1947, being a pioneer in synthetic rubber and earlier chemical products from hydrocarbons.

Boyd has been consultant on many of the most important developments in these fields in recent years, and is a prominent participant in the activities commercial chemical developments. He is also one of the members of *The Petroleum Engineer's* Technical Forum.

Claude A. Rackus is with General Aniline and Film Corp., New York. He was formerly chemical economist on General MacArthur's staff in Japan.

chemicals, notably ammonia and methanol, recently originally were made from coal but are today made more cheaply from natural gas. Industrial ethyl alcohol was originally made here by fermentation from molasses, which in the past has fluctuated widely in price. Today synthetic alcohol from petroleum dampens the violent raw material price fluctuations of fermentation alcohol and stabilizes the price structure of the chemicals made from it. Again the traditional raw material sources have been unable to meet the demand; coke oven benzene and toluene, are examples, and industry has turned to petroleum for relief. Thus petroleum and natural gas have provided industry cheaper chemicals at more staple prices in larger volumes. These factors have been basic to the amazing growth of petrochemicals in the United States, which is reflected in the estimated capital investment in plants and facilities. Some believe that the industry will treble in size in the next 10 years (Table 2).

The increasing petrochemical interest of the petroleum industry is shown by the increasing proportion of petroleum capital invested in processing facilities that has gone to petrochemical plants. (Table 3).

Today the leading petrochemical producer is Carbide and Carbon Chemicals Corporation with Dow Chemical, du Pont, Monsanto, Celanese, American Cyanamid and Allied Chemical and Dye also important factors. Others include Spencer Chemical, Tennessee Eastman, Rohm and Haas, Mathieson Chemical, Commercial Solvents, Penn Salt, Koppers, Diamond Alkali, and Hercules Powder.

In the petroleum industry Shell Chemical is the petrochemical leader with Phillips Petroleum, Esso Standard, Oronite, Lion Oil, Indoil, Cities Service, Continental and Socony-Vacuum also

Petrochemicals Are New Treasure Trove

Petrochemicals now constitute 70 per cent of the U. S. organic chemical industry and are still growing rapidly at 14 per cent annually. This growth exceeds the chemical industry growth rate of 10 per cent a year and that of 5 per cent for the total U. S. industrial output.

Trends most evident in the petrochemicals industry include:

Increasing investment participation by the petroleum industry in petrochemicals.

Increasing dependence on aliphatic hydrocarbon intermediates despite the accelerating demands for aromatics. Ethylene is the most important aliphatic hydrocarbon for chemical production and has increased its dominance at the expense of butylene.

Increasing importance of acetylene from petroleum.

Increasing dependence on petroleum for the aromatic hydrocarbons: Benzene, toluene, and xylene.

Increasing carbon black trend strongly toward furnace blacks made from oil with gas furnace blacks also increasing and the traditional channel blacks decreasing.

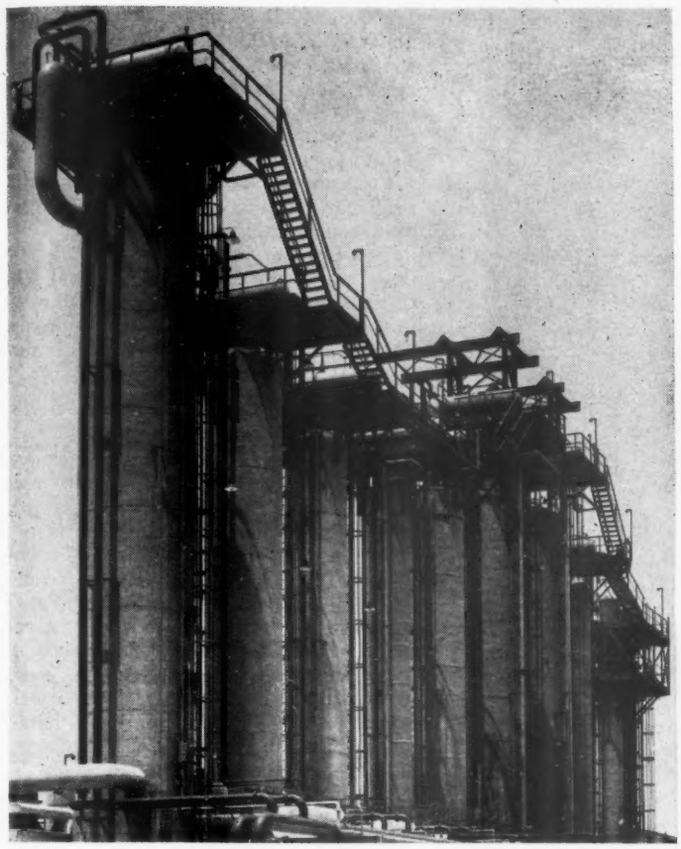
Increasing number of newer chemicals from petroleum for synthetic fibers and plastics.

TABLE 1. Petrochemical growth rates from 1940 to 1951.

Industry	Average annual growth rate, %
Synthetic rubber	67.5
Synthetic detergents	41.4
Synthetic fibers (non-cellulosic)	40.5
Plastics	21.8
Synthetic ammonia	15.7
Synthetic methanol	13.7
Natural gas	9.7
Crude petroleum	4.7

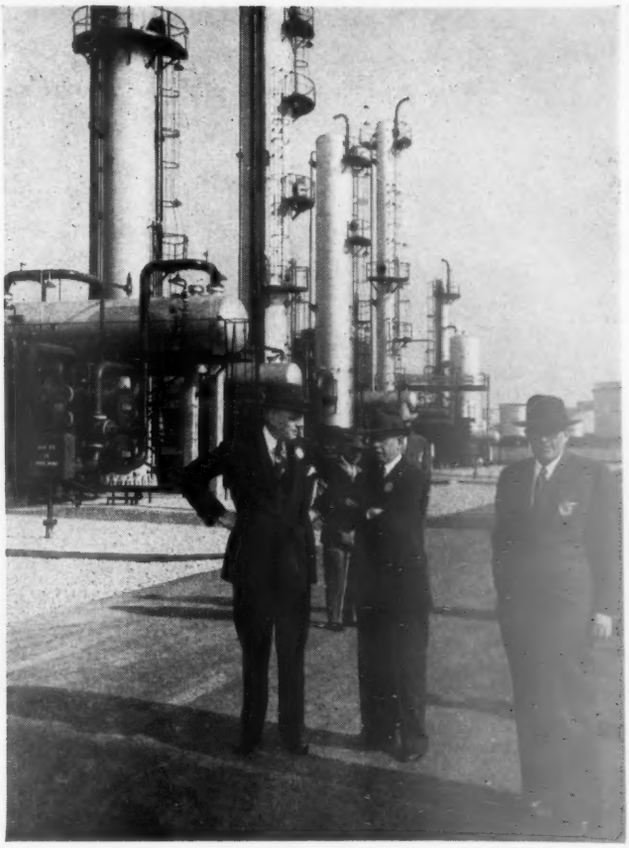
TABLE 2. Capital invested in petrochemicals.

	Total investment	Annual sales	
	Dollars	Dollars	Pounds
1952...	2,000,000,000	1,500,000,000	17,000,000,000
1945...	1,200,000,000		10,500,000,000
1940...	350,000,000		4,100,000,000



Courtesy — Dow Chemical

These styrene finishing towers aid in producing one of the most important chemicals derived from petroleum, utilized in synthetic rubber, in plastics and in many other commercial and industrial products.



California Standard officials, Director A. N. Kemp, Oronite Chemical vice president, George Parkhurst, and Manager C. A. Pollard view huge benzene plant, El Segundo, California.

participating significantly. Union Oil and Hancock Oil are reported to be undertaking petrochemical manufacture.

Joint Ventures

The trend continues towards the formation of joint petrochemical enterprises with petroleum, chemical or rubber companies. The basic pattern is that the petroleum company provides the hydrocarbon raw materials and the partner company provides the chemical know-how and distribution. One or both may provide captive markets. In recent years such joint ventures have included:

(1) Jefferson Chemical, formed in 1944 by American Cyanamid and the Texas Company.

(2) Mathieson Hydrocarbon Chemicals, formed in 1950 by Tennessee Gas Transmission and Mathieson.

(3) National Petrochemicals, organized in June 1951 by National Distillers Products and Panhandle Eastern Pipeline.

(4) American Petrochemicals, formed in 1951 by Cities Service and Firestone Rubber.

(5) In November 1952, Goodrich-Gulf Chemicals set up by Gulf Oil and B. F. Goodrich.

TABLE 3. Capital expenditures for processing facilities by the petroleum industry in U. S.

	Chemical and ammonia	Refining	Portion of total to petrochemical, %
1952 est.....	$ 66,400,000	$ 566,000,000	10.5
1951.....	24,800,000	303,000,000	7.6
1946–1950...	113,800,000	1,793,000,000	6.0

TABLE 4. Petroleum hydrocarbon production for chemical processing. Billions of pounds.

	Aliphatics	Aromatics and naphthenes	Total
1951.....	7.01	1.60	8.61
1950.....	5.13	1.42	6.55
1948.....	3.02	0.89	3.91
1946.....	2.92	0.60	3.52

TABLE 5. Production of toluene and xylenes
Millions of gallons.

	1950	1951	1952
Petroleum toluene.....	45.5	55.7	
Total toluene.....	83.9	101.4	80 est.
Petroleum xylenes.....	62.4	64.4	
Total xylenes.....	71.9	75.7	75 est.

Postwar Production Trends

The postwar growth trend of the petrochemical industry is partially reflected in the production figures on crude petroleum hydrocarbons and natural gas for chemical conversion as reported by the U. S. Tariff Commission.

Table 4 shows this growth trend. Production of these materials has more than doubled in the last five years. In 1951, aliphatic hydrocarbons account for 81 per cent of the total with the C_4 segment accounting for 33 per cent primarily as a result of the increased demand for synthetic rubber in the defense program. Following closely in volume, C_3 hydrocarbons accounted for 25 per cent and C_2 hydrocarbons 21 per cent of the total.

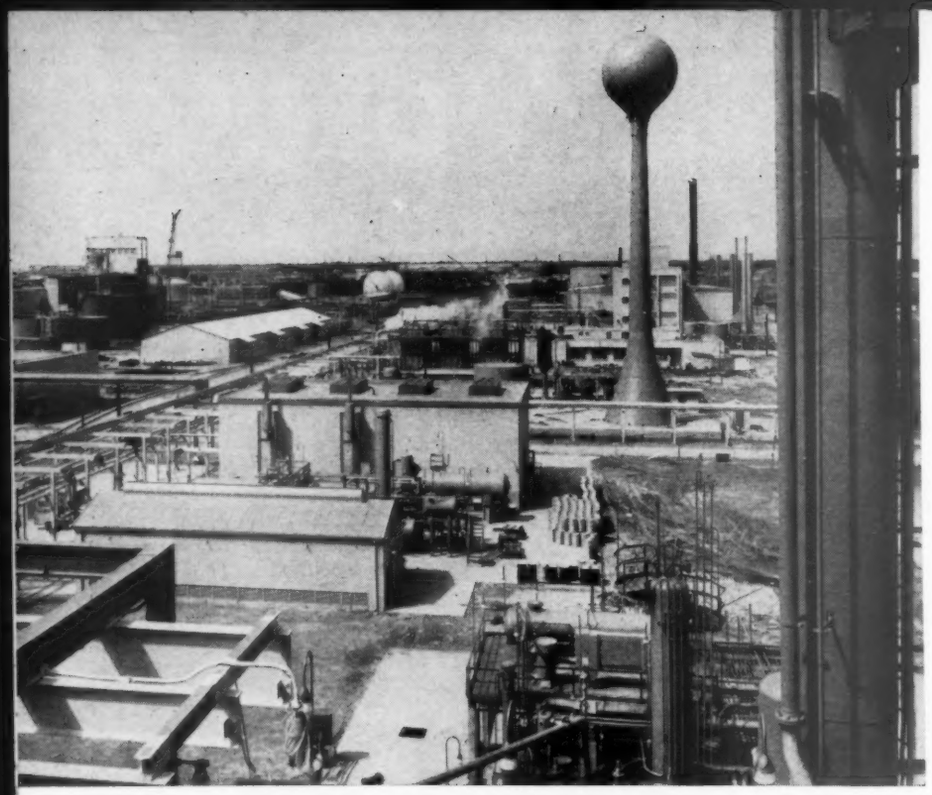
Aromatics

Although aliphatic hydrocarbons are the most important petrochemical raw materials, the output of petroleum aromatic hydrocarbons is of increasing importance in supplementing coal aromatics for chemical use.

Petroleum benzene now commands the greatest interest in this group as it promises to be short in the near future as requirements increase. Petroleum toluene and xylenes are produced in great quantity for aviation gasoline, TNT and solvent uses. The potential supply is more than ample to meet chemical needs. Chemical outlets for xylenes are growing; p-xylene is used for the synthetic polyester fiber, Dacron, and o-xylene for conversion to phthalic anhydride (Table 5).

Production of petroleum benzene in 1951 was about three times that of 1950 and the estimated production for 1952 is 30,000,000 gal. During 1952 benzene production dropped sharply in the spring because of the strike in the steel industry and strikes in the petroleum industry. In spite of the latter, however, a new high in the production of petroleum benzene is expected. Over the long term, benzene requirements for styrene, phenol, and other chemicals are expected to continue their rapid growth.

XUM



One of the petrochemicals manufactured in greatest volume is tetraethyllead as made here in Ethyl Corporation's Houston Ship Channel plant, Texas.

These increased benzene demands must be met by domestic petroleum benzene as similar benzene demands are developing in Europe (Tables 6 and 7).

TABLE 6. Chemical benzene production. Millions of gallons.

	1950	1951	1952
Petroleum benzene	10.1	28.9 (a)	30 (a) est.
Total chemical benzene (b)	186.1	265.7	245 est.
Per cent petroleum benzene	5.4%	10.8%	12.3%

a. Portland Gas to Dow of about 3,700,000 gal not included.
b. except for motor grade now negligible in U. S.

TABLE 7. Estimated chemical consumption of benzene. Millions of gallons.

	1946	1950
Styrene	46.0	61.4
Phenol	25.2	39.2
Aniline	11.6	12.8
Nylon	8.3	11.1
Synthetic detergents	1.6	11.0
Other chemicals	40.1	72.7
Total chemical use	132.8	208.2

Styrene

The increased production of styrene during the past few years reflects the increased demand for synthetic rubber and styrene resins. In 1951, production of styrene reached 707,000,000 lb, approximately 31 per cent over that of 1950. Production in 1952 is expected to be at the level of 1951, partially as a result of some shortages in benzene due to strikes.

Although demands for synthetic rubber held 1951 sales of polystyrene resins to 356,000,000 lb, indications are that about 380,000,000 lb will be sold in 1952. Principal advantages of polystyrene resins are that they are the lowest cost general purpose plastic, they take colors well, and are also extremely resistant to chemicals.

Consumption of styrene for synthetic rubber in 1952 may be about half of the total consumption (Table 8).

The Defense Production Administration has set the January 1955 goal for styrene and methyl styrene at 1,210 million pounds which is an expansion of 93 per cent over the capacity as of January 1951.

TABLE 8. Production of styrene. Millions of pounds.

1952	700 est.
1951	707
1950	539
1948	377
1946	406

Aliphatics

Olefins. The olefins, ethylene, propylene, n-butylenes, and isobutylenes are the most important raw materials for organic petrochemicals. Ethylene is required for the manufacture of ethyl alcohol, ethyl chloride, ethylene oxide and glycol, polyethylene, styrene, and ethylene dichloride. Propylene is used for glycerine, isopropanol, acetone and propylene oxide. Isobutylene is used principally in butyl rubber. The normal butylenes are utilized chiefly in butadiene which in turn is used largely in making GR-S rubber though some is used in making other rubbers, resins, and nylon intermediates.

Ethylene is made by thermally cracking ethane and propane fractions from natural or refinery gases. Ethylene is also formed as a by-product of petroleum cracking operations from which it is being recovered to an increasing extent. Propylene, isobutylene and the normal butylenes are recovered from refinery gases and if not recovered, are usually converted to gasoline by polymerization or alkylation.

It has been estimated that 4.3 billion pounds of the four olefins were consumed for chemical manufacture in 1951 as compared with 3.8 billion pounds for 1950. This is an increase of 10 per cent (Table 9).

1. Ethylene

Of the four major olefins consumed in petrochemical manufacture, ethylene accounts for the largest tonnage and its simpler derivatives are more numerous than those of other petrochemical raw materials.

The more important chemical outlets for ethylene are shown in Table 10.

Ethyl alcohol and ethylene glycol account for over half of the total consumption of ethylene.

Synthetic ethyl alcohol initially spurred by wartime demands has grown steadily upward. Production of synthetic alcohol has about doubled in the last five years and fermentation alcohol is gradually losing ground (Table 11).

Ethyl alcohol goes into hundreds of chemicals and is used in large volumes as a solvent for many products. It is also used to make acetic acid and acetic anhydride that find large volume outlets in cellulose acetate plastics and fibers.

The large wartime use of ethyl alcohol for butadiene for synthetic rubber was discontinued because of cost, but was resumed after hostilities commenced

TABLE 9. Olefins — Consumption for chemicals. Billions of pounds.

	Total	Ethylene, %		Propylene, %		n-Butylenes, %		Isobutylene, %	
1951	4.27	1.74	41	1.17	27	1.14	27	0.217	5
1950	3.78	1.45	38	1.12	30	1.09	29	0.116	3
1948	3.20	1.03	32	0.94	29	1.14	36	0.093	3
1946	3.32	0.75	23	0.75	23	1.70	51	0.119	4

TABLE 10. Ethylene — Consumption for chemicals. Millions of pounds.

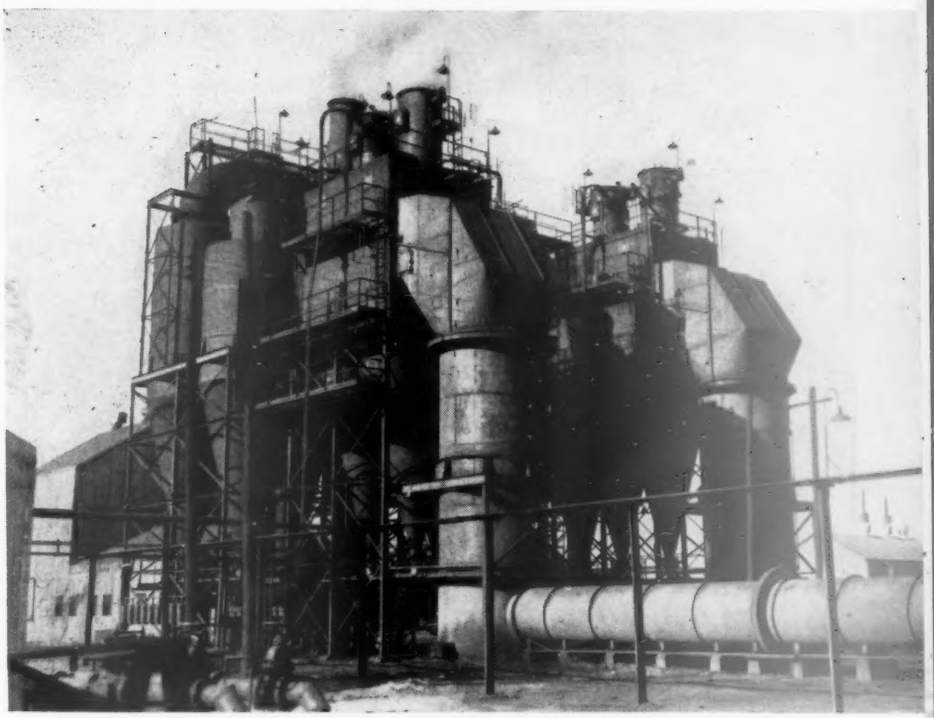
	Ethyl alcohol	Ethylene glycol	Ethylene oxide (a)	Styrene	Ethyl chloride	Ethylene dichloride	Polyethylene
1950	499	345	140	167	141	96	55
1948	379	238	93	117	99	74	19
1946	309	121	62	126	70	46	13

(a) non-ethylene glycol uses.

in Korea in 1950. This brought about increased production of fermentation alcohol. In 1951 the total production capacity of ethyl alcohol was about 400,000,000 gal equally divided between synthetic and fermentation alcohol.

Ethylene glycol and ethylene oxide are to a high degree chemically interchangeable and hence their uses may be discussed together. Automotive antifreeze is the major outlet and takes about two-thirds of the total produced. This market, at least temporarily, is saturated. Chemical derivatives, however, are becoming increasingly important and are used in explosives, resins and plastics, synthetic detergents and synthetic fibers such as Dacron.

Polyethylene is a most rapidly growing petrochemical. The 1952 production was about 120,000,000 lb, double that of 1951 and about 15 times that of 1946. This plastic material has many expanding markets and its future is bright because of its potential low cost and versatile properties. Present facilities are being expanded by Carbide and du Pont while Eastman and Allied are reported planning production of low molecular weight polyethylene.



This furnace black unit of United Carbon in Kansas is typical of modern carbon black production; note practically total absence of escaping black, at variance with old channel black plants.

TABLE 11. Production of 95 per cent ethyl alcohol. Millions of gallons.

Fiscal year	Synthetic	Fermentation	Total
1952	124	122	246
1951	112	122	234
1950	104	61	165
1948	74	101	175
1946	67	106	173

TABLE 12. Production of some propylene chemicals. Millions of pounds.

	Isopropyl alcohol	Synthetic acetone	Propylene glycol
1951	1075	538	88.7
1950	866	459	79.0
1948	834	444	....
1946	489	298	....

TABLE 13. Production of butadiene. Millions of pounds.

	From petroleum	From alcohol
1951	1221	257
1950	610	5
1948	661	0
1946	1011	63

TABLE 14. Production of methane petrochemicals. Millions of units.

	Ammonia, synthetic, short tons	Methanol, synthetic, pounds	Formaldehyde 37%, pounds	Carbon black, pounds
1952	2.02 est.	1030 est.	905 est.	1600
1951	1.77	1220	988	1680
1950	1.57	902	835	1380
1948	1.09	990	617	1300
1946	0.73	510	459	1240

TABLE 15. Estimated consumption of formaldehyde. Millions of pounds.

Phenolic resins	200
Urea resins	180
Melamine resins	60
Pentaerythritol	200
Ethylene glycol	100
Hexamine	70
Paraformaldehyde	40
Textile	25
Miscellaneous	25
	900

2. Propylene

Propylene is consumed mainly in the manufacture of isopropyl alcohol. About three-fifths of it is converted to acetone. The alcohol is also widely used as a solvent, competing with ethyl alcohol in many uses. Other outlets for propylene are synthetic glycerin, propylene oxide and glycol, allyl chloride and allyl alcohol, propylene tetramer for synthetic detergents, and cumene (Table 12).

3. Butylenes

Butadiene for synthetic rubber is the most important chemical outlet for n-butylenes and is used to a smaller extent in making butyl alcohols, almost all of which is used for methyl ethyl ketone solvent (Table 13).

Butadiene, the major component of GR-synthetic rubber is also used in smaller quantities for Buna-N types.

Isobutylene is used for isobutyl rubber for inner tubes and for polymers for lubricating oil additives.

4. Methane

Methane is the major component of natural gas and is used to produce large volumes of carbon monoxide and hydrogen or synthesis gas for ammonia and methanol manufacture. A smaller use of synthesis gas is as the source of aldehydes and alcohols via the oxo process. Synthesis gas is also a source of synthetic gasoline and organic aldehydes, ketones, acids, and alcohols via the Hydrocol process.

A growing use of natural gas is in the manufacture of acetylene by the Sachse and Wulff processes for conversion to acrylonitrile, vinyl chloride, vinyl acetate, acrylic acids and esters, vinyl ethers, and many other organic chemicals. Another petrochemical use of natural gas is for hydrogen cyanide production by cooxidation with ammonia.

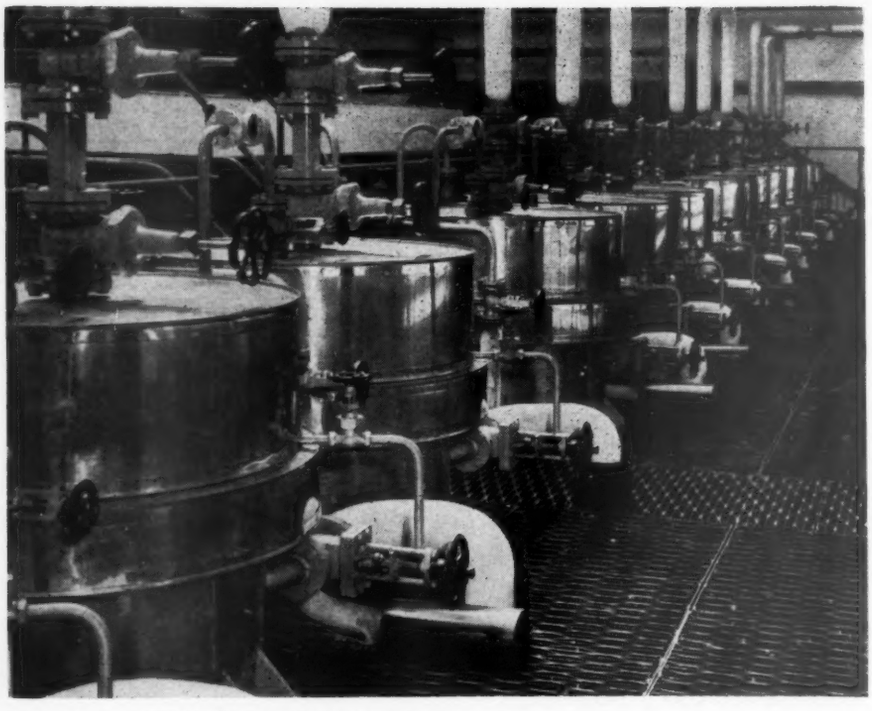
Table 14 is a convenient grouping of chemicals based dominantly but not exclusively on methane.

Ammonia. In the United States today practically all synthetic ammonia production is based on natural gas whereas in 1940 it was based on coal and coke. Ammonia production while increasing over four fold since 1940 still has not kept up with demand for the nitrogen fertilizers; ammonium nitrate, urea, synthetic sodium nitrate, ammonium sulfate and ammonia solutions. Industrial and explosive uses have also grown but less rapidly.

During 1952, production of synthetic ammonia for the first nine months was 1,500,000 short tons as compared to 1,300,000 for the same period in 1951. Over the last decade production has increased at an average of 15.7 per cent per year.

Sales of ammonia for fertilizers are directly related to farm income. In periods of emergency, the need for large crops and rising farm prices stimulate fertilizer sales. Price supports and increasing realization of value of chemical fertilizers point toward continued growth in the demand for synthetic ammonia for this use.

Methanol and Formaldehyde. Methanol is made both by high pressure synthesis and hydrocarbon oxidation. The bulk of production is from synthesis gases. Now almost all the major plants use natural gas as the raw material for synthesis gas. Only small amounts are



Ester plant at Shell's Pernis, Holland, refinery.

made by wood distillation, the original sources of methanol.

About ¾ of the methanol produced has been used for formaldehyde manufacture and for anti-freeze of the volatile type.

Most formaldehyde is made from methanol with smaller quantities made from hydrocarbon oxidation. The bulk of formaldehyde capacity is captive and mainly used for phenolic, urea and melamine resins, pentaerythritol, and some ethylene glycol.

The growth of synthetic methanol over the past decade has averaged 13.7 per cent per year. Production for 1952 of methanol and formaldehyde dropped considerably from the all time highs of 1951, when military demands and scare buying gave rise to sharply increased methanol and formaldehyde output for resins and explosives based on them.

A decreased demand for resins was evident in 1952 for most of the year until demand pushed up at year's end and the output of methanol and formaldehyde rose (Table 15).

Formaldehyde resins are largely used in the automobile, electrical, communication, and protective coating industries. A new promising outlet is in foundry molding. Increased use of these resins over the long term is expected, but their growth will probably not be as rapid as vinyl plastics.

Carbon Blacks. About 95 per cent of domestic sales of carbon blacks is sold to the rubber industry for use as a reinforcing agent. The balance is used chiefly in printing inks, paints, plastics, and carbon paper. Exports of carbon black account for from 18 to 28 per cent of total sales.

The two principal methods of making carbon black are the channel and furnace processes. Smaller quantities are made by thermal decomposition.

With the development of the synthetic rubber industry, furnace black production expanded rapidly. In 1946, furnace black production exceeded that of channel black for the first time and furnace black now accounts for 65 per cent of the total output. Moreover, the trend has been toward furnace blacks made from oil and natural gas and away from channel processes using only natural gas. The oil furnace blacks command higher prices and are superior in use with cold rubber. They now exceed the gas furnace blacks in production.

Total sales of carbon black in 1950, 1951, and 1952 were substantially over that of 1948 and 1949 when tire production and export sales were low. Sales exceeded production reducing stock levels in 1950. In 1951, total output rose 21 per cent, but sales increased only slightly allowing year-end stocks to more than double (Table 16).

The bulk of production is located in the southwest with the Texas Panhandle producing some 40 per cent of the total output. With rising gas costs, however, some of the channel black plants are being moved to West Texas and New Mexico where gas is cheaper.

As new channel black plant requires a higher investment and yields a lower return on investment than the furnace process, the trend is definitely toward increased output of furnace blacks. Furthermore, furnace processes using liquid hydrocarbons are gradually displacing those operating on natural gas (Table 17).

TABLE 16. Carbon black production. Millions of pounds.

	Furnace	Channel	Total
1952	1040	564	1600
1951	1030	646	1680
1950	765	617	1380
1948	621	677	1300
1946	625	619	1240

TABLE 17. Carbon black production trend.

		1950		1951	
Type of Black	Feed	Millions of pounds	%	Millions of pounds	%
Furnace	Oil	325	23	540	32
Furnace	Gas	440	32	491	29
Channel	Gas	617	45	646	39
Total		1382	100	1677	100

Acetylene. Acetylene is a chemical raw material of rapidly increasing importance. Traditionally it has been made from calcium carbide, which in turn is made from coke and lime in electric furnaces. Recently, in the United States, where large acetylene production at a single site can be justified, attention has been given to methods of acetylene manufacture based on petroleum. The partial oxidation of methane (or ethane) with industrial oxygen for acetylene was originated in Germany and there known as the Sachse process. Monsanto is using it, probably in modified form, in their new acetylene chemical plant at Texas City. Acetylene can also be made by thermal cracking of these same feed stocks. The Wulff process does this in a regenerative furnace in an alternating heating and cracking operation. Texas Eastman is building a plant of this kind at Longview, Texas. Carbide and Carbon Chemicals is reported to be making acetylene from petroleum gases at their Texas City plant but no details have been released.

In comparing carbide, Sachse, and Wulff acetylene economics the magnitude of production is a major factor. There is no simple unqualified answer to the question "Which is the best process?" Fixed charges or charges proportional to the capital investment bulk large in the mill cost of acetylene. The proper depreciation charge to employ for the tried established carbide process as compared with the industrially newer Sachse process or the newest Wulff process is a matter of opinion to be settled, for a particular case, by arbitrary decision.

New Chemicals

Some of the newer chemicals made from petroleum are adiponitrile for nylon from butadiene, methyl ethyl and methyl vinyl pyridines from acetaldehyde and ammonia, iso-alcohols by the Oxo process, and the phthalic acids from the xylene isomers for use in synthetic fibers and plastics.

Sources of Information

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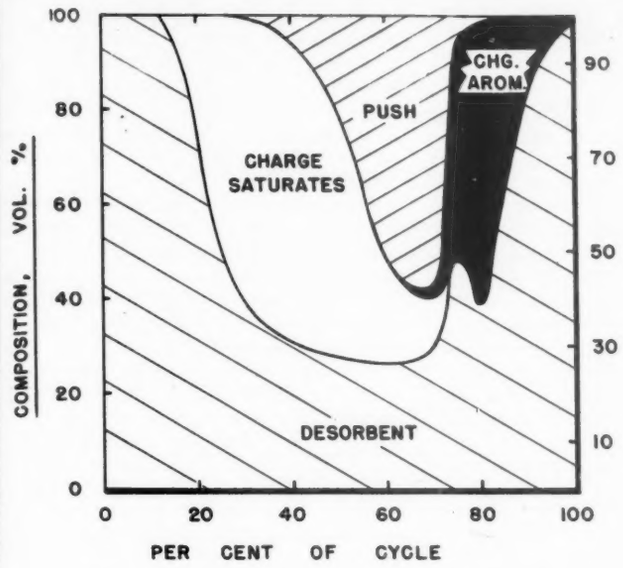


FIG. 1. Variation in gel column effluent during cycle.

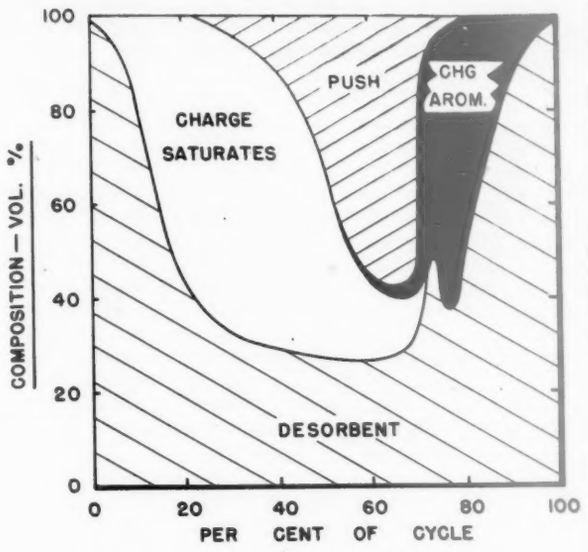


FIG. 2. Effluent diagram using minimum desorbent.

Versatile Process for Aromatics Recovery†

Unique sequence of steps involving solid adsorbent, desorbent, and recycle permits concentration of aromatics from many refinery fractions

F. R. SHUMAN* and D. G. BRACE*

NITRATION toluene was the first pure aromatic produced in quantity from petroleum. The great expansion in refinery facilities for its production occurred during World War II. A comparable expansion is now taking place in petroleum benzene plants, as a result of the chemical industry's faster growth than its coal tar benzene supply. More recently the need for the individual xylene isomers has led to their isolation from petroleum.

At the same time specifications for high volume solvents have been trending toward more purity, both in the aromatic and non-aromatic types.

Many processes have been tried for separation of these aromatic compounds in high purity. Methods that were developed for lube refining have been modified and new extraction processes have been developed. Most of these are at their best on one or two particular chemicals, and lose efficiency or ease of operation when used on other stocks. The Arosorb process, recently developed by Sun Oil Company, is equally applicable from benzene to aromatics in the gas oil range.

How this new separation process operates, the charge stocks and products that can be handled, and the physical equipment that is involved will be covered in this article.

Process Principles

Essentially, the Arosorb process is a newly developed method for separating aromatic compounds from paraffins and naphthenes. Unlike other processes that do a similar job, the Arosorb process separates by using silica gel adsorption rather than extraction or azeotropic distillation. Silica gel has practically the same chemical composition as sand, but it is synthesized in such a way as to produce particles consisting of myriads of tiny pores. As a consequence each particle has a tremendous surface area, something like 80 acres per pound. In addition to great surface area silica gel has the property of selectively holding chemical compounds on its surface. Although the affinity for different molecular types varies widely, the Arosorb process utilizes the gel's much greater affinity for aromatic compounds over saturates.

The method for applying this marked selectivity is simple. A feed stock is charged to a column packed with gel, and the amount of feed is regulated so that all the aromatics are retained by the gel. Then a saturate liquid such as pentane or butane is pumped into the column to displace feed stripped of aromatics. This saturate stream is referred to as the "push liquid," and constitutes the smallest portion of the cycle. After the aromatic-lean feed is displaced, the aromatics are recovered from the gel by washing with an aromatic liquid, called the desorbent, which boils outside the range of the feed. The cycle is then repeated. It is quite possible to remove the charge aromatics by using a paraffinic or naphthenic desorbent, but excessive amounts of desorbent generally are required.

Assuming that the desorbent is an aromatic liquid, Fig. 1 illustrates the variation in gel column effluent during the cycle. This diagram represents a

†Presented before Western Petroleum Refiners Association, regional meeting, Beaumont, Texas, February 12-13, 1953.

*Sun Oil Company.

cycle for a gel column already on stream, and at the beginning of this particular cycle the gel column is filled with desorbent from the preceding cycle. First the paraffins and naphthenes in the charge ("charge saturates") begin to come through mixed with desorbent from the past cycle. The saturates reach a maximum, and taper off as the pentane push appears. The push reduces the charge material in the effluent down to a very small fraction. Next the charge aromatics come through sharply, slightly mixed with pentane, then decrease until they too disappear leaving the effluent entirely desorbent.

Segregation of saturate and aromatic products is done by splitting the effluent into two streams. The choice of points in the cycle for switching from saturate to aromatic tankage is set by product purity requirements.

Regardless of where the cut point from aromatic to saturate is made, both streams will contain a substantial amount of desorbent. The bulk of the pentane push liquid appears in the saturate stream, although a small quantity is present in the aromatic. In any case provision must be made for separating desorbent and push from both saturate and aromatic products by distillation.

Generally, the relative size of the aromatic and saturate streams depends on the aromatic content of the feed stock. The cycle depicted by Fig. 1 is for the case where more desorbent has been added than is necessary. Consequently, the aromatic-to-saturate cut point is not critical, and the relative size of the two streams could be changed to suit. This is illustrative of a plant that is coming on stream. After the plant is lined out the desorbent is reduced to a minimum for economy. Then the effluent diagram looks like Fig. 2.

An analogous situation occurs with the push liquid. The amount of push is fixed to reduce the overlapping of charge saturates and aromatics to the minimum level. As with desorbent, more push would be used during plant start-up.

Plant Description

To translate the foregoing operations into commercial practice several auxiliaries must be added. As silica gel has a far greater affinity for water than for hydrocarbons water must be excluded by drying all streams entering the gel column. The simplified plant flow sheet, Fig. 3, shows alumina-type driers on the feed, desorbent, and push streams. If, as a result of mal-operation, the gel does pick up enough water to substantially reduce its capacity for feed it may be regenerated by passing hot hydrocarbon vapors through the gel column.

The alumina driers also remove certain trace compounds from the feed which are so strongly absorbed by silica gel that they act as poisons. For example, by pretreating a 300-400 F straight-run naphtha fraction with activated alumina before charging to the gel column, the effective life of the gel was increased from about two months to over a year.

After drying, the treated feed is pumped into the top of one or more silica gel columns, followed by push and desorbent. The time for charging each stream is fixed by a conventional cycle timer on each gel column. If several gel columns are used the cycles are staggered to smooth out the pumping load and to minimize variation in feed to the fractionation columns on the product streams. For a one gel column plant fractionation tower feeds can be smoothed by using two tanks in parallel on the saturate and aromatic lines, each large enough to hold one cycle.

The sequence of distillation following the gel column depends upon the type of feed stock being processed. The flow sheet on Fig. 3 is drawn for a plant running a 300-400 F naphtha, with benzene as desorbent and pentane as push. The aromatic effluent leaving the gel column is distilled to remove a benzene stream containing the small amount of push present. This slightly diluted benzene is satisfactory for desorbent and is taken as overhead product from the aromatic distillation tower.

Pentane push is recovered for rerunning as overhead from the first tower on the saturate side of the plant. Benzene desorbent is then separated from the saturate product in the second tower. Both benzene streams are combined for reuse as desorbent.

For production of high purity aromatics it is essential that no charge saturates be left in the returning desorbent. As shown by the effluent diagram, Fig. 2, the desorbent is approximately 70 per cent of the aromatic effluent. Thus, if the desorbent is contaminated by charge saturates to the extent of ½ per cent, there will be a 1.2 per cent loss in aromatic purity. The same reasoning applies for good separation between aromatic product and desorbent if a low aromatic content saturate product is desired. Desorbent contamination is particularly important in the case of nitration grade benzene manufacture, where the impurities must be under 1 per cent. In this case, high saturate purity normally also is required since high saturate purity means high recovery of benzene.

Now a few more important details in the plant design. As Fig. 4 illustrates, the points in the cycle at which the effluent is switched from aromatic to saturate and later back again must be closely controlled, particularly if the push liquid and desorbent are being held to a minimum. This accurate switching is accomplished by following the progress of the cycle with an instrument that measures the dielectric constant of the effluent. As the gel column

FIG. 3. Simplified flow chart of Arosorb process.

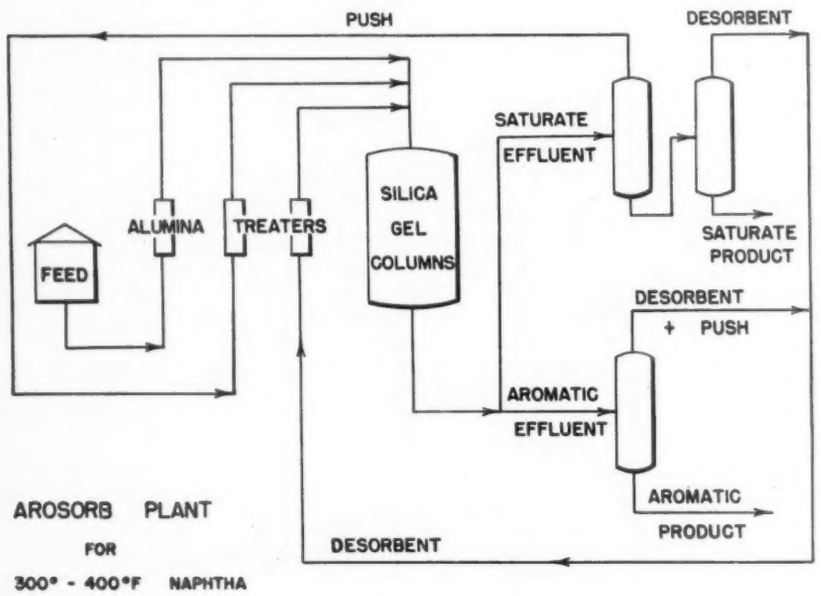
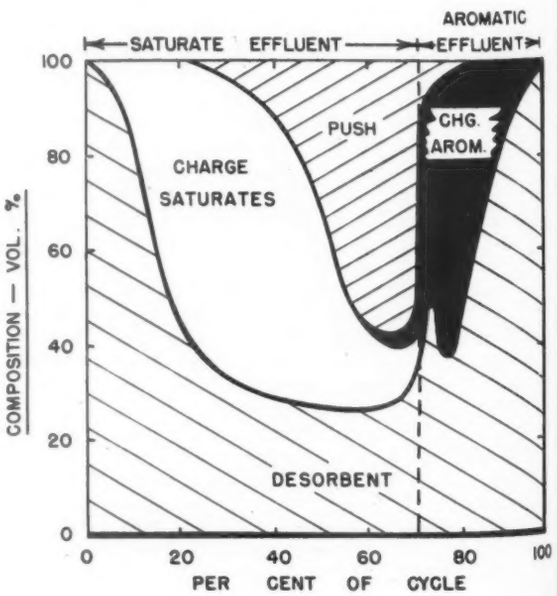


FIG. 4. Close control of switching operations is necessary for efficient operation.



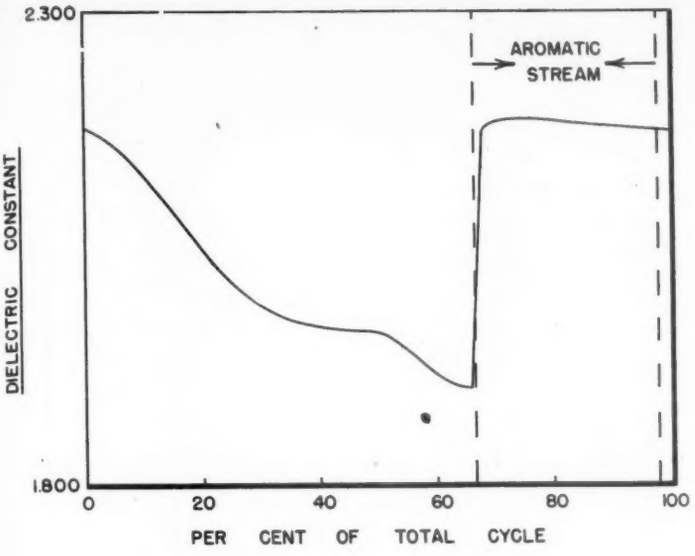


FIG. 5. Variation of dielectric constant of stream during cycle.

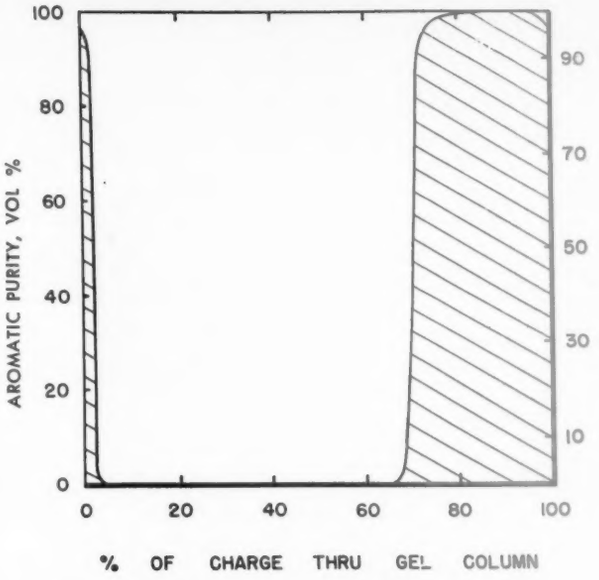


FIG. 6. Purity of charge aromatics from column.

cycle progresses the instrument plots the dielectric constant, which passes through a sharp minimum (see Fig. 5) just before the aromatic portion comes from the column. This minimum actuates a timer that controls the valves on the aromatic and saturate lines. Thus, the cycle time is automatically reset for each cycle.

Feed Stocks and Products

The choice of materials for push and desorbent, and the piping arrangements for the distillation section of the plant are determined by the proposed charge stocks. Push and desorbent should boil reasonably far from each other and from the feed to facilitate the eventual separations by distillation.

Distillation considerations impose one limitation on the three components of the gel cycle. Diffusion imposes another. For good separation liquids entering a gel column should have a viscosity of not over 0.65 centipoise. This requirement necessitates operating at slightly elevated temperatures, or diluting certain high viscosity charge stocks with pentane or butane. The list of suitable feed stocks is long. A few representative ones will be discussed.

Benzene Reformate. The lowest-boiling charge that would be run in an Arosorb plant for aromatics would be a benzene-containing reformate, boiling between 140 and 190 F. The benzene content might be about 35 per cent, and for a nitration grade product the finished benzene must be of at least 99 per cent purity.

Fig. 6 illustrates the separation that occurs in the gel column in terms of benzene purity. This graph represents the results of distilling push and desorbent from cuts taken throughout a complete cycle, and analyzing the charge fraction for benzene content. Benzene purity was then plotted against per cent of total feed per cycle to give a true picture of the amount of high purity benzene that can be expected from each cycle after distillation. If the cut points are made properly benzene of as high as 99.6 per cent purity can be produced. In actual operation the plant would be started up taking just such a narrow cut for the aromatic effluent. After the plant was lined out, the width of the aromatic fraction gradually would be broadened until the lowest desirable purity and the maximum recovery were reached.

Since benzene is a relatively high priced product, high recovery is important. The possibility of employing a recycle has probably become apparent. Another look at the effluent diagram, Fig. 7, will illustrate the point. The recycling is accomplished by adding another cut point to the cycle, and a third effluent line is needed to permit mixing this intermediate cut with the incoming feed. The recycle stream contains aromatics from both the feed and desorbent, and reduces the plant capacity for fresh charge by about 15 per cent, depending on the quantity of effluent recycled.

Through recycle high benzene recovery can be obtained along with extreme purity. For example, with no recycle the possible recovery of 99.4 per cent benzene is 75 per cent, but by recycling 9 per cent of the effluent the recovery becomes 92 per cent.

An interesting sidelight on recycle is that when charging benzene reformate containing 1 per cent olefins, the olefins build up in the recycle stream to the extent of 3 per cent. Then they begin to go out of the plant in the saturate product. As a result, the Arosorb process produces a benzene low in olefins. This minimizes the amount of subsequent treating required to pass the acid wash color test.

The Arosorb processing of a benzene-containing stock can best be done with a xylene stream as the desorbent. Xylenes are low in viscosity, high enough in boiling point to make distillation simple, and in adsorbability, close to that for bezene. The latter is desirable for optimum results.

Butane is probably the best push liquid for benzene-containing feeds. The fact that the xylene desorbent and butane push boil on opposite sides of the charge requires that another distillation tower be added to the three in the plant previously described. The extra tower removes push liquid that would throw off the benzene boiling range. By including this fourth tower the boiling range of the benzene product can be controlled very accurately since both initial and end point are fixed by separate fractionators. The overhead from this fourth tower is recycled to feed to recover any benzene carried over with the push.

When extremely high purity is not needed, push liquid may be eliminated from benzene processing as will be shown later.

Toluene Purification. The next higher boiling aromatic that may be purified to reagent grade by the Arosorb process is toluene.

The requirements for running a toluene feed are generally the same as benzene. The boiling points of toluene (231 F) and xylenes are closer than desirable. For this reason a higher boiling aromatic fraction such as obtained from a 340-400 F naphtha would be selected for desorbent. Since the viscosity of these aromatics is higher than desired at room temperature, the gel column would be operated at 130 F to reduce the viscosity to 0.65 cp.

Xylene Reformate. The next higher-boiling group of aromatics currently in demand as chemicals are ethyl benzene and the xylenes, boiling between 277 and 292 F. Although they can be produced in 95 per cent purity by careful fractionation before and after a catalytic reforming operation, about half the potential xylenes are lost by this method. If the reformer feed is cut high

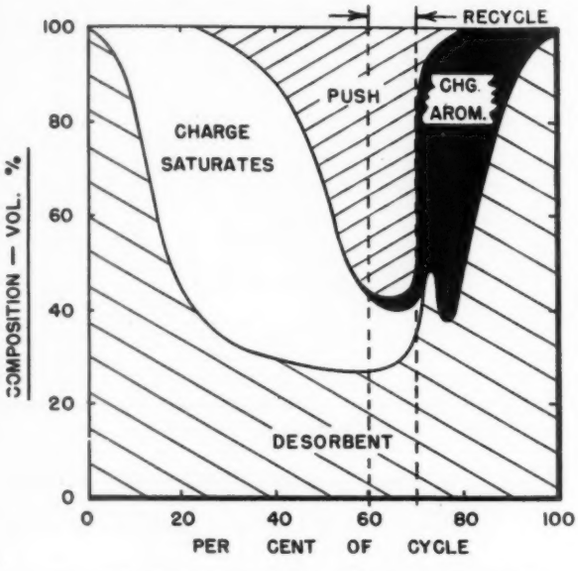


FIG. 7. Process routine with recycle operation.

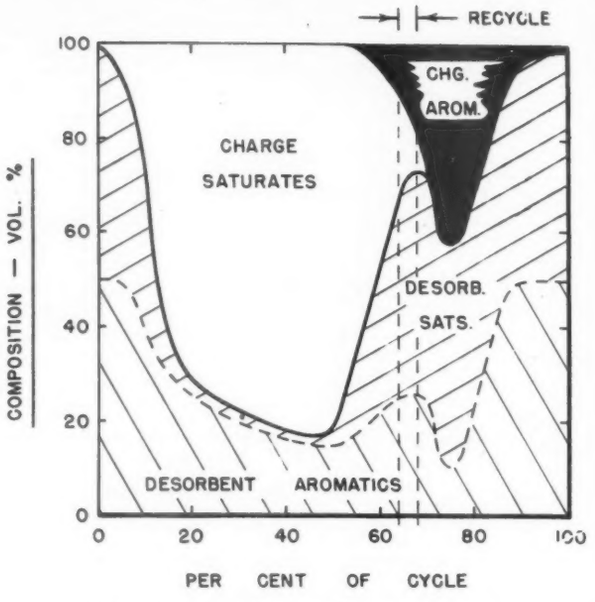


FIG. 8. Composition diagram of effluent during one cycle with no push liquid, using a low aromatic content desorbent.

enough to include the natural xylenes, as well as xylene-forming naphthenes, the reformate product should contain at least 40 per cent aromatics, thus making an ideal feed for an Arosorb plant. This method of operation eliminates much of the distillation load in xylene production, since reformer feed cut points then are not critical.

By using benzene desorbent the xylene operation in the Arosorb plant becomes the reverse of running a benzene-bearing reformate. The xylene product can readily be purified to 99 per cent, making a good starting material for separation into xylene isomers of high purity. The olefin content will be low. As the push liquid, again either butane or pentane, and the benzene desorbent will boil below the xylenes only three distillation columns will be required. The push and desorbent would then be taken overhead in the aromatic and saturate towers. Push would be split out from the saturate overhead in a third tower.

Benzene, toluene, and xylenes are all presently needed as high purity chemicals. Although substantially 100 per cent purity can be reached by diluting the charge saturates as is done in some other aromatic purification processes, these aromatics can be Arosorb processed to well above 99 per cent purity without recourse to this complication.

300-400 F Straight-Run Naphtha. Beyond the xylene-boiling range the number of aromatic compounds becomes so numerous that separation of individual compounds is largely precluded. They are normally used for solvent purposes only. As solvents the maximum purity usually needed is about 95 per cent, and boiling range limits are frequently nominal. Consequently, processing such a feed is less expensive.

A typical charge for solvent manufacture is a 300-400 F straight-run naphtha. Its aromatic content will vary from 15-30 per cent depending on the crude source. High-solvency slow-drying aromatic solvents and low-odor slow-drying saturate solvents result from gel processing such feeds. The aromatic solvent, if made to 95 per cent aromatics, has a Kauri-Butanol solvency of 94, compared with 38 for a naphtha feed of 17 per cent aromatics.

The saturate product can be produced with less than a 1 per cent aromatic content. At that level the odor that remains is due to presence of naphthenes and consequently is distinctly different from the original both in degree and type. The solvency of these saturates is somewhat better than pure paraffinic solvent. If low-odor saturate product is required, a feed having a 340 F initial boiling point is suggested.

Regardless of whether the 300-400 F charge to the Arosorber is high or low in aromatic content the processing is about the same. As the viscosity of such a charge stock is just over the 0.65 cp limit for efficient gel separation, either the feed must be diluted with push liquid or the gel column must be operated at about 130 F. There is little difference in distillation requirements as 130 F operation reduces the gel capacity for feed to about the extent that the push plus desorbent load per barrel of feed equals that for diluted feed. Choice depends on local conditions.

As with xylene feed, benzene is the preferable desorbent, and again only three distillation columns are needed. Distillation loads are small, a result of the 120 F spread between charge stocks and desorbent.

Kerosine. There are two ways to process kerosine. It can be run to give a good split between aromatics and saturates, producing a very slow-drying aromatic solvent of higher solvency than the 300-400 F cut, and a very slow-drying saturate solvent of low odor. On the other hand it can be processed to segregate only a part of the aromatics. These aromatics would be of high purity, and again be of very slow-drying high solvency type. The saturates, representing possibly 90 per cent of the original kerosine would be sold for low-smoke lamp oil. This second type of operation allows for high charge throughput for a given amount of solvent recovery.

Kerosine has too high a viscosity to process undiluted, even at 150 F. The feed to the Arosorb plant must then be diluted with about 35 per cent pentane.

Recycle Catalytic Gas Oil. Recycle catalytic gas oil also offers two interesting systems of processing. If run for good separation and high purity products the saturate fraction becomes an unusual diesel fuel with a 70 cetane number. Typically this product can be blended one part to two of the feed gas oil to make a 50 cetane fuel. The aromatic product concurrently made is suitable as an insecticide solvent.

The other alternative treatment for cycle stock is to remove only a small portion of the aromatics. A number of solvent extraction procedures have been applied to a cycle stock to reduce the coking tendency in the second cracking pass. The principle is to reduce the dicyclic aromatics that are detrimental from a carbon-forming standpoint. The high selectivity of silica gel can be used for this operation. For the same coke make the gasoline yield upon catalytic cracking is appreciably increased by the

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gel treatment. As only small amounts of aromatics need be removed the fresh charge to the gel case is adjusted to give a low desorbent to charge ratio, and therefore an economical operation.

Improvements for Economy

The fundamentals of the Arosorb process and several possible feed stocks have been discussed. Much of what has been said applies to making reagent grade aromatics. Where lower purity is practical both operating and investments costs can be materially reduced.

The major expense in investment and operating costs of an Arosorb plant is the distillation facilities. The Arosorb process is analogous to solvent extraction, with the combination of gel and desorbent acting as an extremely selective solvent. As in extraction plants the big cost is solvent recovery, the solvent in an Arosorber being desorbent and push. This has been the point of attack toward a more efficient process.

Elimination of Push Liquid. The most important change that has been made in the original aromatic-desorbent push operation is the elimination of push. This has been accomplished by using a desorbent of relatively low aromatic content, say 65 per cent. As the desorbent flows through the gel column it is separated, in effect, into aromatic-rich and saturate-rich fractions. The more saturate part of the desorbent acts as push, displacing the charge saturates from the gel column before desorption of the feed aromatics begins. Fig. 8 is an effluent diagram for a cycle employing diluted desorbent. Notice the low aromatic content of the desorbent following the saturate part of the cycle. That a saturate-rich fraction is necessary is shown by Fig. 9 comparing the aromatic recovery at various purities for cycles with push, without push, and with diluted desorbent. No recycle was used in this study in order to magnify the differences. The curves illustrate the comparative aromatic recoveries at various product purities. This plot demonstrates that maximum aromatic purity is achieved with push. If 99.2 per cent product purity is enough, desorbent dilution is sufficiently effective.

When push is replaced by diluted desorbent, the desorbent amount is increased by an amount equivalent to the push it replaces. Net effect, however, is the elimination of one large distillation tower that would otherwise be required to recover push. If less than nitration purity is acceptable in a benzene or toluene operation diluted desorbent eliminates two distillations.

Reduction in distillation load occurs as purity-recovery requirements are decreased. As has been mentioned, when only a portion of the charge aromatics need be removed the amount of fresh feed per cycle can be increased considerably for the same amount of desorbent. A similar reduction in distillation load occurs with any substantial reduction in charge aromatic content. Gel capacity for fresh feed is largely limited by its capacity for aromatics.

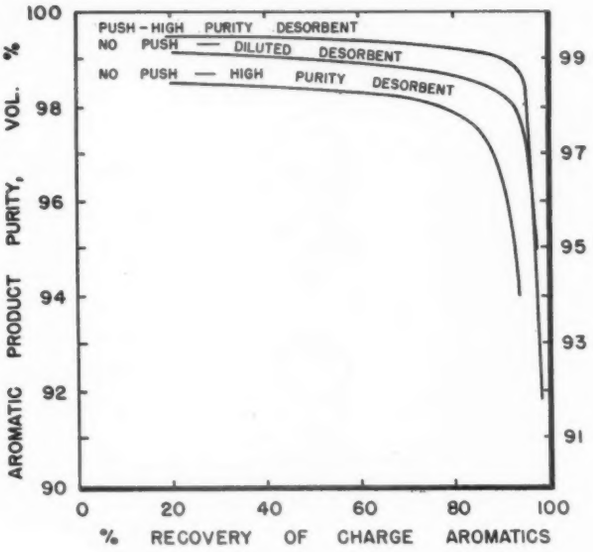

FIG. 9. Aromatic recovery for different purities under various operating conditions without recycle.

Barrel solvent* per barrel charge.

Charge stock	Reagent purity 95% recovery	High purity 95% recovery	Solvent purity 95% recovery	Partial dearomat.
Benzene reformate	2.9	2.2		
Toluene reformate	3.1	2.3		
Xylene reformate	3.3	2.4		
300 F – 400 F naphtha	...	1.1	0.8	
Kerosine	...	...	1.2	0.7
450 F – 600 F cat. gas oil	...	...	3.1	.8

* Solvent = push + desorbent.

Conclusion

The choice between various operating schemes hinges on the feeds that are to be processed and the products that are desired. The reduction in push and desorbent solvent recovery requirements with decreased purity-recovery is illustrated by the table. Reagent grade aromatics require push, desorbent and recycle whereas a purity level of 98-99 per cent would be reached merely with diluted desorbent and recycles. Producing solvent grade aromatics eliminates the need for both push and recycle, but uses diluted desorbent. Partial dearomatization requires only aromatic desorbent, which should be about 95 per cent aromatic to minimize the desorbent amount required.

The table further illustrates that even for reagent-grade products, such as nitration grade aromatics, the ratio of solvent to charge is substantially independent of feed boiling range up to the point where viscosity becomes a major factor.

Equipment Design. Distillation and drying equipment for an Arosorb plant are of conventional design. The gel columns are more unique, and require different construction than an alumina drier, for example. Whether one or more will be needed can be estimated by assuming that the cross sectional area should be sized to give a fresh charge rate of about 0.4 gpm fresh feed per square foot, so that a 500 bbl per day plant would require two cases 5 ft in diameter. The height should be about 20 ft, giving a gel inventory of 34,000 lb.

Processing Costs. Roughly, the operating costs for an Arosorb plant range from 1 to 3 cents per gallon of charge, again depending on the type of feed and products.

The installation of an Arosorb plant gives the refiner a most versatile unit for purification of aromatics. It will allow him to process any boiling range from benzene to gas oil with high purity for both saturate and aromatic products as desired. An Arosorb plant involves no corrosion problems, requires no hard-to-handle chemicals, and it operates without excessive heat or need for refrigeration.

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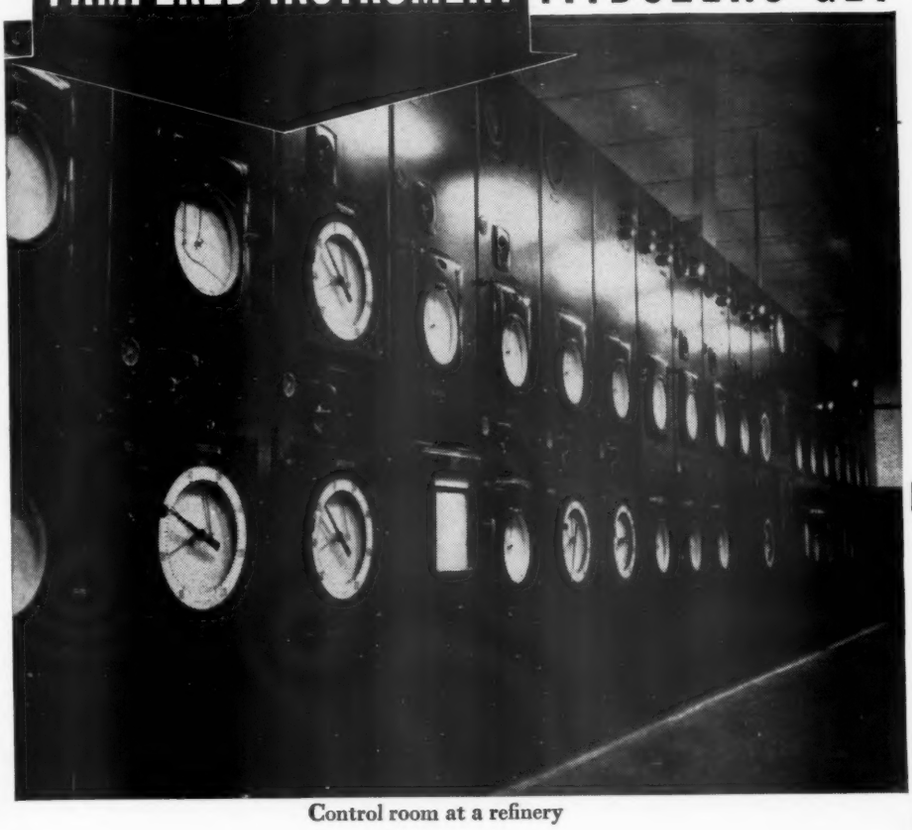

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Cleaning contaminated tank surfaces by spraying viscous chemical solvents over them requires high pressure, positive displacement pumps. Above is assembly of pumps, solvent tank, application hose and sprayer, used as a mobile unit.

HOW TO CLEAN STORAGE TANKS

Use of chemical solvents, fitted specifically to the job at hand, will solve many clean-up problems of refining storage

R. P. ROBINSON† and E. W. HUDGENS*

THE problem of periodic tank cleaning must be faced by practically every company using tanks for the storage of raw materials or finished products. Some of the reasons that make cleaning necessary are: (1) change in product storage, (2) removal of sludge or corrosion products, (3) general structural repairs, or (4) preliminary preparation for painting. In the past, such methods as sand blasting or mechanical scraping and wiping have been employed, however, these frequently require complicated scaffolding and are hazardous, time consuming, and tedious.

A new method of cleaning either internal or external surfaces of tanks has been introduced recently, consisting of special techniques in the application of specifically formulated chemical solvents. This method is applicable to almost any type of cleaning problem, and has proved equally successful in removing organic and inorganic deposits, as in the removal of paint and other protective surface coatings.

The principle advantages of the chemical cleaning of tanks, over the older mechanical methods, are: (1) faster, (2) less hazardous, and (3) a more efficient and thorough cleaning job is obtained.

As the chemical solvents used in tank cleaning are liquid, they are able to reach surfaces that are inaccessible to mechanical methods, such as around rivets and seams or irregular surfaces where sediment can become firmly lodged. This penetrating characteristic of the liquid solvents used for chemical cleaning, is particularly advantageous when it is desired to convert a tank from one type of product—such as a heavy fuel or crude oil—to a more refined and clearer product. All refined petroleum products must meet certain standards of purity and uniformity, and one of the tests given to materials such as gasoline and kerosine, is for color. As gasoline or kerosine are readily discolored by any darker oil, it is highly important that the storage facilities have every trace of contaminating material removed. This is where chemical cleaning can play an important part by removing any contaminating material from around irregular shaped surfaces, inaccessible to cleaning by mechanical means.

There are two principal methods of chemically cleaning storage tanks. On the smaller sized tanks, where the cost is not prohibitive, the soaking method is used. The units first are filled with the proper solvent; reaction of the chemicals on the unwanted deposits is allowed to proceed to completion; the tank is then drained and cleaned surfaces passivated to minimize oxidation.

In the case of larger size storage tanks, it is not economically practical to completely fill the tank with the chemical solvents. The most recently developed procedure utilizes a thickened chemical solution that is sprayed onto the tank. It may be used on either the inside or outside surfaces of the tank. This thickened solvent clings to the surfaces that are being cleaned. After the chemical reaction between the solvent and the deposits is complete, the material is flushed off leaving the contaminated surfaces clean. The chief advantage of this thickened solvent is that it is not necessary to completely fill the tank in order to clean it. The economics of this method, especially on larger

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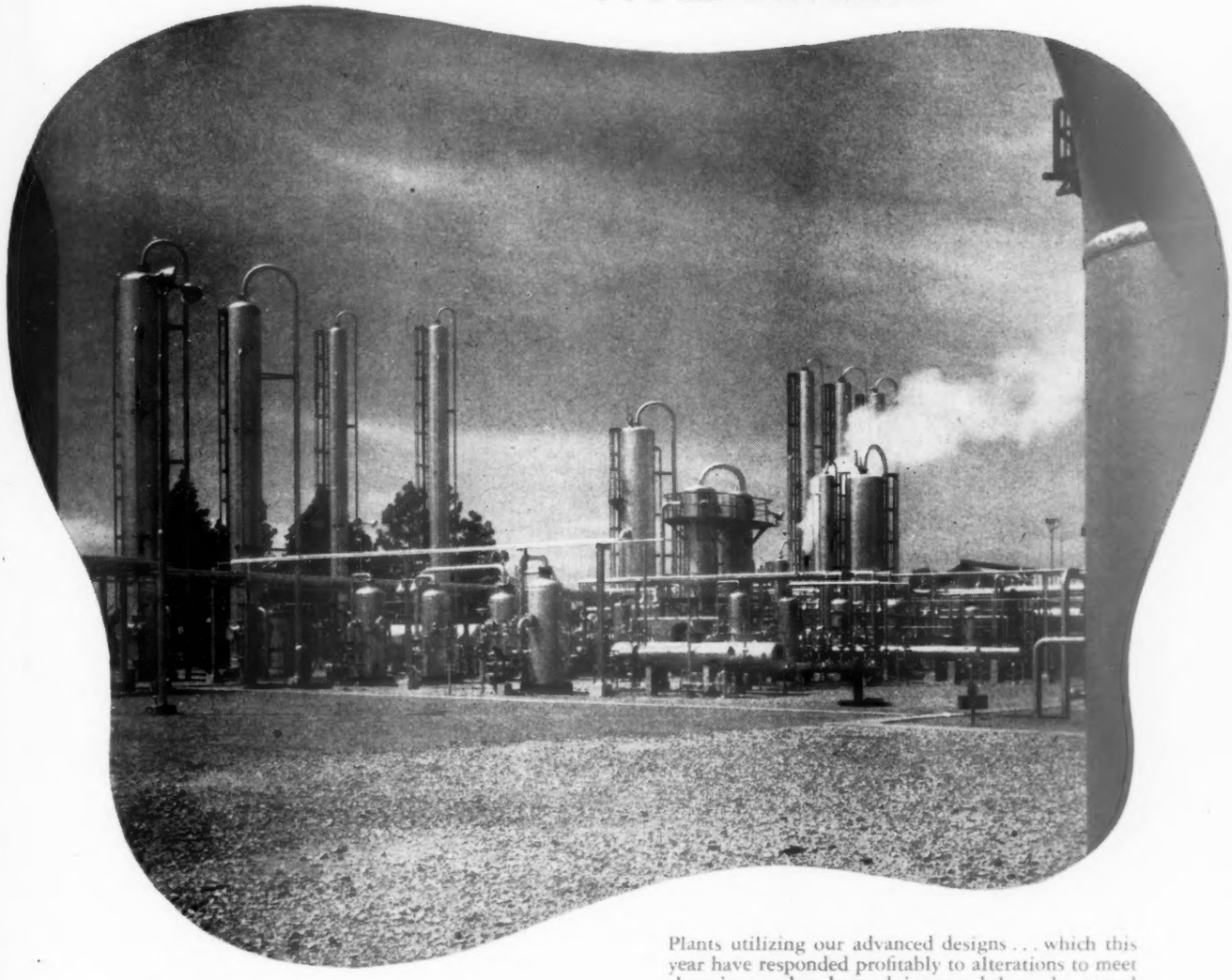

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tanks is readily apparent. Also, the solvent can be sprayed upon the surface quite rapidly, greatly reducing the amount of time necessary to conduct a cleaning treatment. For example, the entire inside surface of a 6000-bbl oil storage tank was completely covered with thickened solvent within 20 min by means of this method.

In removing paint by this method, a thickened solvent containing methylene chloride as its active ingredient has been developed. Within a very few minutes after this material has been sprayed onto the tank surface, the paint begins to crinkle, blister, and peel off. After a suitable period of time, the remaining chemical solvent and loosened paint flakes can be flushed off with water.

Specially formulated alkaline solutions applied by high pressure jetting equipment are used for the removal of oils and greases. Inorganic deposits are removed by the application of a jelly-like inhibited acid material. In every case, the application is rapid and easy and requires little or no scaffolding.

A number of successfully performed tank cleaning jobs are listed in Table 1. A more detailed description of several additional case histories will illustrate the effectiveness of chemical cleaning methods.

Seven 216,000-gal storage tanks were cleaned for a midwestern steel company. The tanks were 36 ft 9 in. in diameter by 27 ft 3 in. high, with a system of heating coils about 8 in. off the bottom. The tanks had been used for storing fuel oil and gasoline and were being cleaned prior to conversion to sulfuric acid storage. The problem was to remove all of the oil and tar films from the tank walls and ceilings. The tanks were cleaned by spraying a hot, dilute alkaline solution, containing a wetting agent, on the ceilings and inside walls of the tanks. As it was possible to spray the thickened solvent on all internal surfaces from the floor of the tank, it was not necessary to erect any platform or scaffolding inside the tank. Special high pressure hoses and nozzles were employed to give increased cleaning efficiency.

Six of the tanks were cleaned in pairs. This was accomplished by connecting two separate hoses to the service company's high pressure mobile pumping unit. By having a cleaning crew in each of the tanks, both could be cleaned simultaneously. In this manner it took approximately five hours to completely clean these six tanks.

Mobile cleaning unit and crew preparing to "attack" surface fouling on tall type of plant tank.

In another case, five 6000-bbl capacity gasoline storage tanks were cleaned for a midwestern oil company. The tanks were 40 ft in diameter by 37 ft high and had oval roofs. Two sets of steam coils, consisting of 23 pieces of 2-in. piping, 20 ft long, connected to 3-in. headers, were mounted about 2 ft off the tank floors. The problem was to remove a rust film from the inside tank surfaces, prior to their being converted to bright stock storage.

As this deposit consisted of an acid-soluble inorganic scale, the thickened inhibited acid formula was employed for this treatment. The tank walls, floor, and steam coils were first coated by means of sprays. The thickened solvent was then allowed to remain overnight in contact with the contaminated surfaces. The following morning the acid was flushed off with high pressure water, and the tanks sprayed with a dilute alkaline solution to insure complete neutralization and passivation of the surfaces. The tanks were then dried out by turning steam into the system of coils installed in each tank. The freshly cleaned surfaces were then sprayed with a light oil to prevent any future rusting. This entire operation required less than 24 hours for each tank.

One of the largest tanks to be cleaned by this new method was a 50,000-bbl capacity fuel oil storage tank used by a southwestern chemical company. The problem was to remove a rust deposit, coated with an oil film, from the wall, floor, and ceiling of the tank. All traces of oil had to be eliminated as the company planned to use the clean tank for storing ethylene glycol.

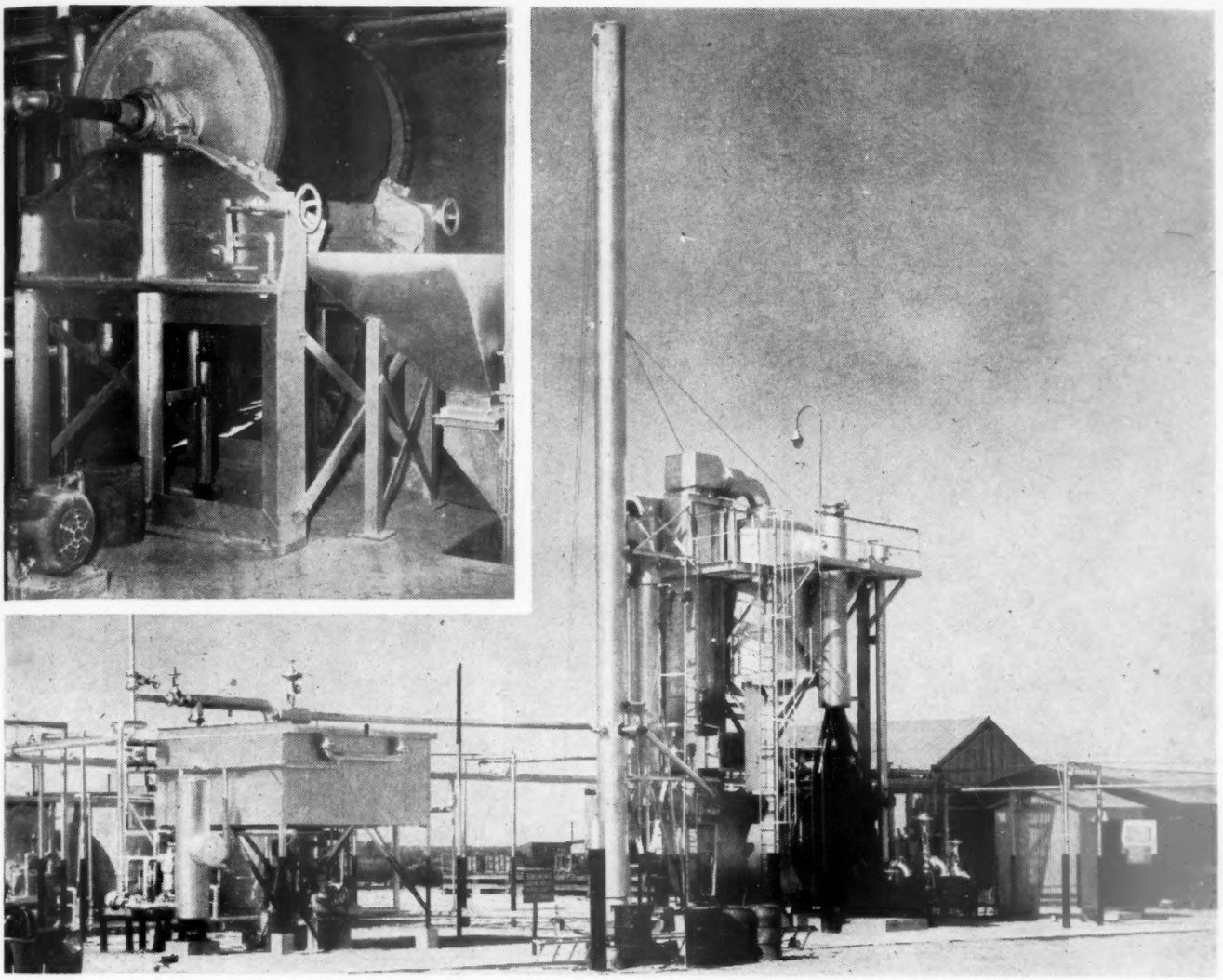
The tank was 40 ft high by 100 ft in diameter and was of welded steel construction. It had a conical roof and 13 steel supports placed in rows across the tank. Prior to cleaning, the operator purged the tank of all fumes by alternately turning steam and air into it.

The cleaning procedure was approximately the same as in the previous case history. The principal difference was that after the thickened mixture had been thoroughly flushed off with water, an alkaline solution containing a wetting agent was jetted over the interior to insure the removal of any remaining traces of oil. This procedure resulted in a completely successful cleaning treatment.

As chemical cleaning in most cases provides so many advantages over mechanical cleaning, not only from the economical standpoint, but from that of the increased efficiency of the cleaning itself, it is believed that this technique will find increased usage in industrial plants and throughout the oil fields, as it becomes better known. * * *

TABLE 1. Typical tank cleaning operations using chemical solvents.

Type industry	Number and size of tanks, in gallons	Type deposit removed	Reason for cleaning
Automobile	Two 12,400 (Underground)	Paint sludge, and rust	To convert to civilian use.
Steel	Three 10,000	Fuel oil sludge	To convert from fuel oil to sulfuric acid handling.
Distillery	One 425,000	Paint and rust	Converting from molasses storage to alcohol storage.
Automobile	One 15,000 (Underground)	Varnolene	Converting from stoddard solvent storage to anti-freeze storage.
Refinery	One 500,000	Oil and rust	Converting from oil storage to chloroform storage.
Chemical	One 7,000	Rust and organic polymer	Periodic clean up.
Chemical	Two 300,000	Mill scale	New tanks being put into service.
Automobile	One 10,000	Lead sulfate sludge	Periodic clean up.
Chemical	One 25,000	Mill scale	New tank being put into service.
Distillery	One 78,000	Oil and rust	Converting to other service.
Food Mfg.	Two 5,000	Organic and rust	Periodic cleaning.
Utility	One 210,000	Oil and rust	Cleaned for dismantling and shipping.
Chemical	One 2,500,000	Oil and rust	Converting from fuel oil to caustic soda storage.
Chemical	One 2,000,000	Oil and rust	Converting from fuel oil to ethylene glycol storage.



Fifteen ton per day sulfur recovery plant of Sid Richardson Gasoline Company, Kermit, Texas. Insert is sulfur flaker at Sid Richardson Carbon Company plant, Odessa, Texas.

Sulfur Recovery Practices in Oil Industry†

Sulfur from by-product waste gases is assuming important position, and its growth parallels demand on world market

R. A. GRAFF*

RECOVERY of elemental sulfur from by-product waste gases, obtained during the process of desulfurization of gaseous and liquid hydrocarbons, is rapidly assuming an important position in the heavy chemicals industry.

Only 10 years old, this phase of the petroleum processing industry has grown to a point where, today, almost ten per cent of the U. S. supply is produced by the oil and gas industry.

The growth of this particular phase of petroleum processing closely parallels the demand for sulfur on the world market, and has been stimulated by more favorable price and marketing conditions that have occurred within the past few years.

In addition to more favorable marketing conditions, larger quantities of high sulfur content natural gas and crude oils are now being made available, and while 10 years ago, a natural gas containing 15 mol per cent hydrogen sulfide was considered a geological curiosity, today, natural gas containing 40 to 55 mol per cent hydrogen sulfide is not too uncommon. This higher sulfur content trend in gas and petroleum products is probably a result of more well completions being made in deeper

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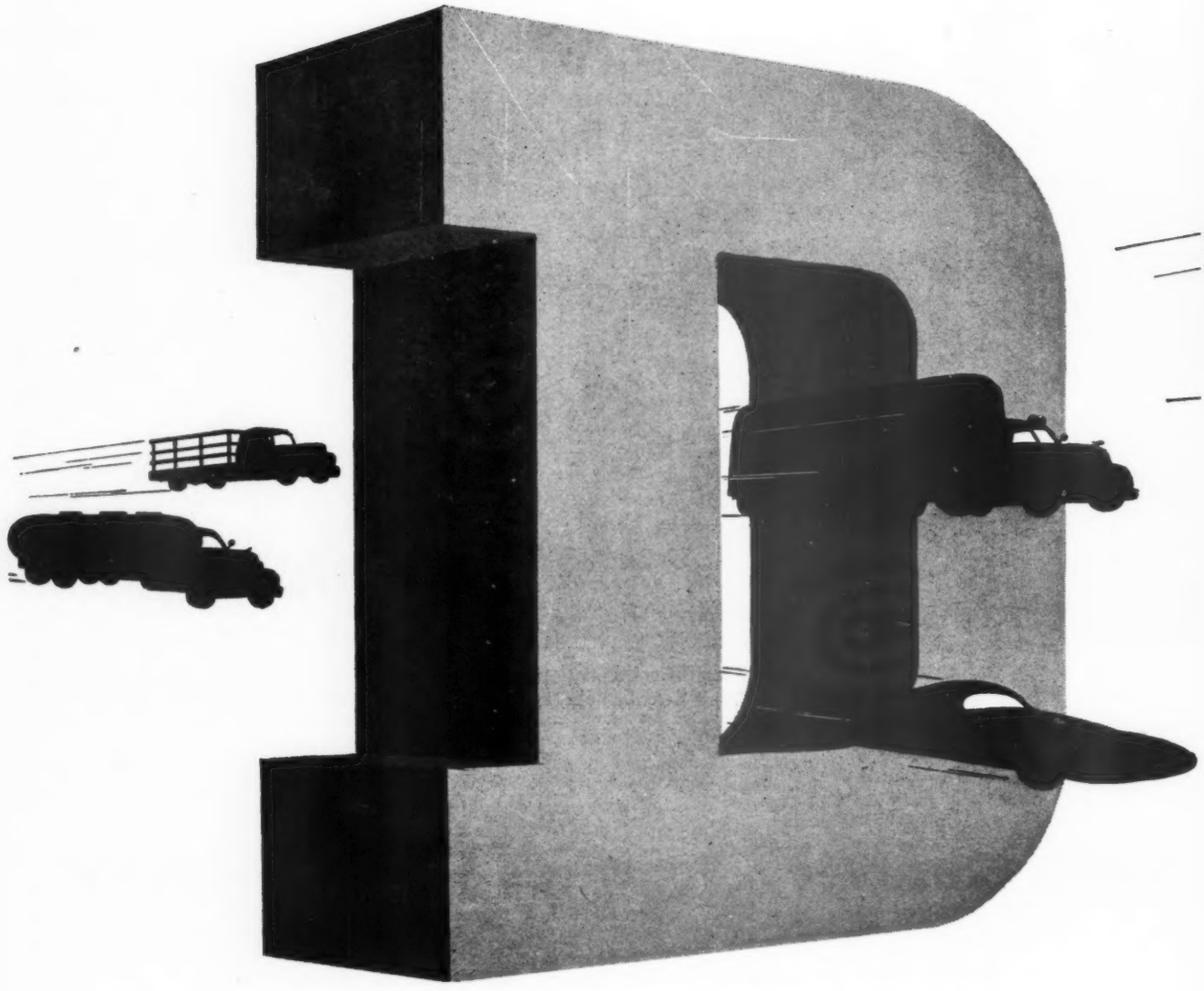
†Presented at January 6, 1953, meeting of Dallas Chemical Engineer's Club.

*Graff Engineering Company, Dallas, Texas.



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pay zones, where high bottom hole temperatures and pressures, combined with the presence of metallic sulfide deposits in the pay zone, favor the formation of hydrogen sulfide and sulfur-containing hydrocarbons.

Eventually, this hydrogen sulfide is separated from natural gas by means of the amine or phosphate processes, while in the case of crude oil, catalytic processes convert liquid organic sulfur compounds to hydrogen sulfide, which is separated in the same manner, and is available for processing into elemental sulfur.

The recovery of elemental sulfur from hydrogen sulfide is usually carried out by reacting hydrogen sulfide with only the required amount of oxygen contained in air to produce water vapor and elemental sulfur, rather than sulfur dioxide, which is the normal product of combustion of hydrogen sulfide. This operation must be carried out under carefully controlled conditions to assure commercial yields of the product. The recovery of elemental sulfur from hydrogen sulfide bearing gases by the partial combustion method is a very old process, and has been in commercial operation for over a hundred years.

Probably the earliest type of sulfur recovery unit is the partial combustion process involving the so-called Claus oven, named after the inventor. In the language of today, the Claus oven could be called a catalytic process reactor, for such was the function of that item.

In the Claus process, hydrogen sulfide bearing gas is burned in the top of a vertical kiln with the theoretical quantity of air to satisfy the equation shown below:

$$H_2S + \tfrac{1}{2}O_2 \longrightarrow H_2O + S$$

The hot gases pass down through a bed of catalyst contained in the reaction zone, where the reaction continues at temperatures between 1800 F and 2500 F. The capacity of the Claus oven is limited by the outside surface area available for the dissipation of heat, and of necessity, the early Claus process installations were quite large in size, in proportion to the quantity of sulfur produced.

The capacity of the usual Claus oven was in the range of 2-6 cu ft of hydrogen sulfide per hour, per cubic foot of catalyst available. A flow diagram of a typical early Claus sulfur recovery unit is shown in Fig. 1. A gas mixture containing a minimum content of 15 mol per cent hydrogen sulfide will produce a self-sustaining reaction, and in view of the high internal temperature developed in the oven, a catalyst with refractory properties is required, and bauxite is usually used for this purpose.

A typical Claus installation made in Europe in the middle thirties for producing two tons of sulfur per day would consist of a brick-lined steel oven, containing approximately 500 cu ft of catalyst arranged in a bed 3-6 ft deep. Sulfur vapor from the Claus oven was condensed in an air cooled shell and tube condenser, or desuperheated with a high pressure water spray, followed by an electrostatic precipitator to separate the condensed sulfur.

It is interesting to note that the early Claus process was used primarily for the recovery of sulfur from the waste gases produced as a by-product of the manufacture of carbon disulfide.

The most favorable temperature for the operation of the catalytic converter employed in sulfur recovery units, is a temperature approximately 50 F higher than the sulfur dew point in the reacted gases leaving the catalytic reactor. This temperature varies with the inlet feed gas composition, but is usually in the range between 450 F and 650 F, and equilibrium conversion in this temperature range is usually between 88-93 per cent of theory.

Inasmuch as the original Claus process did not provide for the removal of an appreciable quantity of heat from the system, and temperatures as high as 2500 F were generated in the center portion of the Claus kiln, poor equilibrium conversion conditions were established that resulted in low conversion yields in the range of approximately 60-70 per cent.

Early efforts to reduce reactor temperatures and improve yields were centered about the installation of cooling coils located in the catalyst bed, however, as these coils do not materially reduce the catalyst surface temperature, little improvement in yield was noted.

Some Claus process plants constructed abroad in the late thirties incorporated a vent gas recirculation system to dilute the incoming gas to a low hydrogen sulfide concentration (15-20 per cent), and as a result, Claus kiln temperatures were controlled at approximately 1500 F, which resulted in slightly higher yields. A flow diagram of a typical installation of this type is shown under Fig. 2.

The first material advance in sulfur plant design practices was initiated by the I. G. Farbenindustrie, A. G. of Frankfurt, Germany.[1] The I. G. Claus process modified the old Claus process in such a manner that the total reaction was carried out in two separate steps, and the major portion of the heat liberated in the reaction was accomplished in the first step, which involved the burning of a one-third portion of the hydrogen-sulfide-bearing gas stream under a steam boiler to produce sulfur dioxide, and by-product steam.

This sulfur dioxide was then reacted with the two-third balance of the hydrogen sulfide stream to produce elemental sulfur and water vapor, and a comparison of the old and new methods involved are shown, in accordance with the equations below:

Old Claus Process:

$$(H_2S)_g + (\tfrac{1}{2}O_2)_g \xrightarrow[1\ ATM]{60^\circ\ F} 1/6(S_6)_g + (H_2O)_g + 232\ BTU/SCF\ H_2S\ (in\ catalyst)$$

I. G. Claus Process:

Step No. 1:

$$(H_2S)_g + 3/2(O_2)_g \xrightarrow[1\ ATM]{60\ F} (SO_2)_g + (H_2O)_g + 588\ BTU/SCF\ H_2S\ (in\ steam\ boiler)$$

Step No. 2:

$$2(H_2S)_g + (SO_2)_g \xrightarrow[1\ ATM]{60\ F} \tfrac{1}{2}(S_6)_g + 2(H_2O)_g + 53.5\ BTU/SCF\ H_2S\ (in\ catalyst)$$

It will be noted that the major portion of the heat of reaction is produced in the steam boiler, where this heat can be removed rapidly by the evaporation of water. Approximately two pounds of steam is generated, per pound of sulfur recovered.

As compared to the old Claus process, which permits an average catalyst space velocity of 3, the I. G. Claus process permits an allowable catalyst space velocity of 100-200, which greatly reduces the

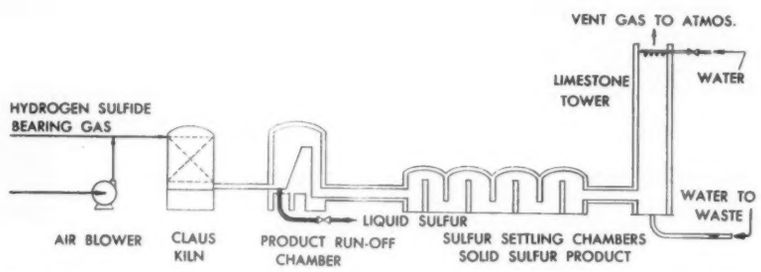


FIG. 1. Flowchart of early Claus process.

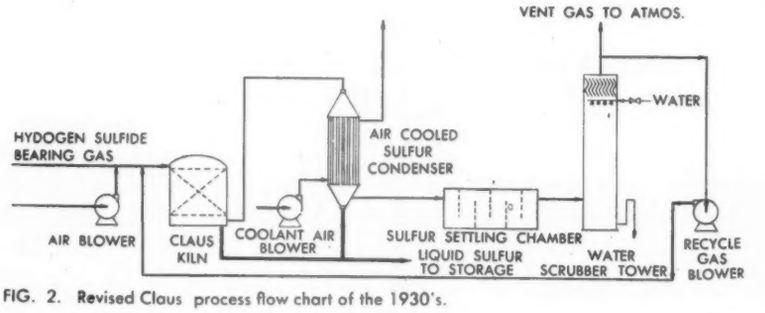


FIG. 2. Revised Claus process flow chart of the 1930's.

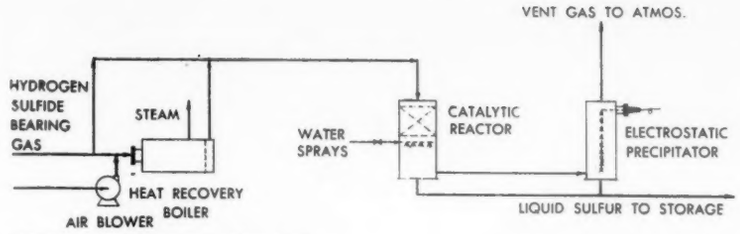


FIG. 3. I. G.-Claus process flow chart.

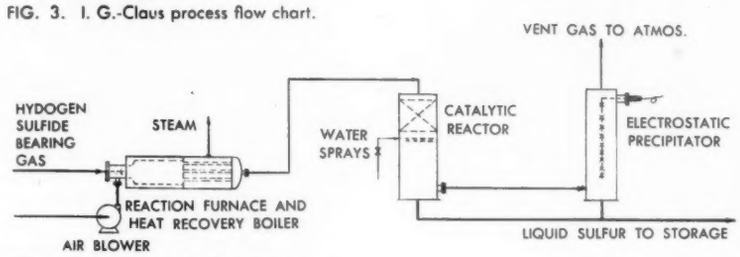


FIG. 4. Improved I. G.-Claus process.

size of the equipment involved. A flow diagram of the I. G. Claus process is shown under Fig. 3.

An even more recent advance by the I. G. Company[2] involves the carrying out of the old Claus reaction in a firebrick lined combustion chamber, followed by cooling the combustion gases in a waste heat boiler, and then passing the partially cooled gases to a catalytic converter for final adjustment of equilibrium conditions at a temperature of approximately 750 F.

This improved I. G. Claus method involves even less equipment; however, it is limited to hydrogen sulfide bearing gases that contain only small quantities of hydrocarbons, since in the absence of sufficient air to produce an oxidizing atmosphere in the combustion chamber, any hydrocarbons present may be thermally decomposed to carbon, which eventually deposits on the catalyst and also appears in the product. Fig. 4 illustrates the flow diagram for this type of operation.

A further disadvantage of this improved I. G. Claus process is the fact that if an appreciable quantity of carbon dioxide is present in the hydrogen sulfide bearing gas stream, carbon oxysulfide is formed in the combustion chamber, and a second stage of catalytic conversion is often necessary to obtain high yields of sulfur. The formation and decomposition of carbon oxysulfide is shown in accordance with the equation given below:

$$(H_2S)_g + (CO_2)_g \rightleftarrows COS + (H_2O)_g \pm 39\ BTU/SCF\ H_2S$$

The formation of COS is favored by temperatures above 1000 F, while the hydrolysis is favored by temperatures in the range of 750 F.

A process similar to the improved I. G. Claus process is carried out at a few locations in this country, and called the "Claus-Chance" process.[3]

A further modification of the improved I. G. Claus process consists of eliminating the catalytic converter following the reaction in the combustion chamber, and condensing the sulfur formed at this point, followed by reheating the gas from the sulfur condenser and passing the gas to a second stage catalytic reactor. Approximately 60 per cent conversion is obtained in the first stage operation, while approximately 80 per cent conversion is obtained at the second stage, thus producing an overall recovery of approximately 92 per cent.

Methods for the condensation of sulfur from the vapor effluent from the catalytic sulfur converter or reaction furnace vary considerably at each plant location.

The condensation of liquids from large volumes of fixed gases has always presented a serious problem, and in the case of the condensation of liquid sulfur from reactor gas, considerable difficulty has been experienced with sulfur fog formation. Fog is formed by the condensation of a vapor at a point in the gas stream, rather than on the metallic heat transfer surface, and in the case of shell and tube equipment, this is occasioned by cooled under-saturated vapors leaving the walls of the cooling surface after condensation of sulfur, and then contacting the saturated vapor at the center of the heat transfer tube, resulting in precipitation of fine liquid droplets in the gas stream, rather than on the tube surface.[4]

The European practice for condensation and collection of liquid sulfur has been to deliberately form fog in the catalytic reactor effluent gas by desuperheating the hot gases to a temperature approximately 275 F by means of a water spray system, followed by electrostatic precipitation to remove the extremely fine droplets of sulfur from the gas stream.

Plants operating in this country either use an air cooled sulfur condensing system,[5] in which gas velocities and the rate of heat transfer are such that partial undersaturation of the gas stream does not occur, or by the use of a contact cooler-scrubber arrangement, in which system, liquid sulfur is used to desuperheat, condense, and scrub sulfur droplets from the gas stream.[6] It is the usual practice to circulate liquid sulfur over a packed tower, and the liquid sulfur is cooled by conventional shell and tube equipment, prior to recirculation through the system.

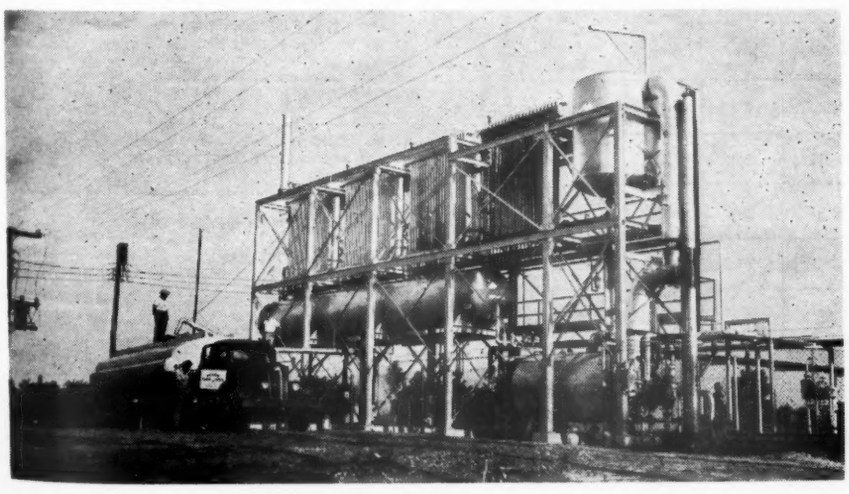
A few American sulfur condensing systems employ both indirect heat exchange in conventional shell and tube equipment, followed by scrubbing the effluent vapors with a circulating stream of molten sulfur, prior to discharging vent gases to the atmosphere. Low pressure steam is usually generated on the shell side of the shell and tube sulfur condenser.

Cooling of the recirculating liquid sulfur stream may sometimes be carried out by means of water injection under the surface of the molten sulfur; however, this must be undertaken with caution, since there are many operating variables that will cause difficulty in this connection.

The general problem of handling hydrogen sulfide bearing gas streams that do not contain a sufficient quantity of hydrogen sulfide to support combustion, is one that has occasionally arisen, and has been solved in a satisfactory manner.

In general, by-product gases containing approximately 25 mol per cent hydrogen sulfide will support combustion quite satisfactorily; however, it is necessary that the boiler firebox zone be

The 10-ton per day sulfur unit at Lion Oil Company, El Dorado, Arkansas.



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lined with refractory brick to maintain proper combustion conditions.

In the case where the gas stream will not burn satisfactorily, it is possible to produce sulfur dioxide by burning a portion of the sulfur produced, and admixing this sulfur dioxide with the main gas stream, prior to entering the catalytic reactor. The balance of the equipment is of conventional design.

While this type of operation involves the use of a sulfur burner, the sulfur burning operation itself is relatively quite simple, and involves bubbling air through a vessel containing molten sulfur at approximately 600 F. At this temperature, the oxidation reaction is self-sustaining, and the effluent vapors from the sulfur burner are cooled to condense vaporized sulfur, and are reheated prior to mixing with the feed hydrogen sulfide gas stream.

Another method of attacking this problem involves the addition of sufficient hydrocarbon fuel gas to a one-third portion of the hydrogen sulfide bearing gas stream, followed by combustion of the one-third stream, and proceeding as in the case of the I. G. Claus process.

Sulfur, as produced from hydrogen sulfide by partial oxidation, is often marketed in liquid form, and shipment is made in insulated tank cars or motor trucks. This method of handling involves the absolute minimum in labor costs, and is preferred by all operators, except those located at isolated points from the market.

In some instances, liquid sulfur is solidified into flakes by means of a conventional water cooled drum flaker unit, similar to the type employed for flaking caustic soda, and the flaked sulfur is then stored in overhead bins, and handled by mechanical conveying equipment.

A few sulfur recovery plants employ sulfur block storage, in which case, the produced sulfur is allowed to solidify in a restricted outdoor storage area, and as the sulfur is required for marketing, it is crushed by dropping a dragline bucket on the deposit, and is loaded in cars by the same equipment.

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* * *

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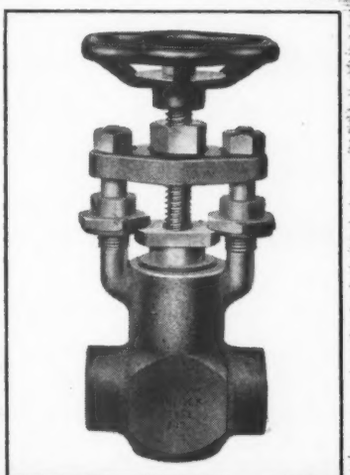

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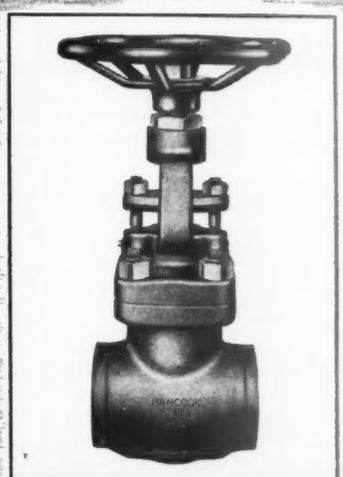

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Correlation of Petroleum Oil Distillations

ASTM D-158-41 distillation data may be predicted by calculation from Bureau of Mines Bulletins

J. O. FRANCIS[1] and M. VAN WINKLE[2]

Abstract

A large quantity of analytical distillation data on crude oils from many sources are available in the U. S. Bureau of Mines Bulletins and Reports. Much of the data have not been correlated with that derived from other distillation methods with which properties of oils are commonly related.

Distillation studies on 10 petroleum oils and fractions were conducted using the distillation procedure as outlined in Bulletin 490 of the Bureau of Mines and ASTM Method D-158-41.

Correlations relating the 50 per cent boiling temperatures and slope increments of the distillation curves derived from the two methods were developed and are presented. The correlations can be used for predicting ASTM distillation data from Bureau of Mines distillation data.

THERE are many distillation methods in use today for the evaluation of the vaporization properties of petroleum oils and fractions. Also, a number of correlations between the properties of petroleum oils and fractions and distillation characteristics derived from the various methods have been developed. These correlations are necessary for the evaluation of various distillation characteristics of the oils, such as true boiling point distillation curves and flash distillation curves, and various physical properties of the oils.

In the various Bureau of Mines publications much crude oil distillation data are available. These are derived, however, from a specified method and procedure that is not the same as other common distillation methods and procedures. In order to have maximum use of these data, correlations between the methods are necessary.

Correlations are available in the literature[4,5,6] for relating ASTM distillation data as well as many of the physical properties of petroleum oils. The purpose of this investigation was to obtain a relationship whereby ASTM distillation data could be predicted from Bureau of Mines distillation data.

Methods

Distillation studies were made using ASTM Method D-158-41[1] and the distillation procedure of The Bureau of Mines Routine Method for the Analysis of Crude Petroleum as outlined in Bureau of Mines Bulletin 490.[2]

The complete Bureau of Mines method of analysis as outlined in Bulletin 490 was not used, as only the procedure for obtaining distillation data was under study. As the properties of the individually distilled fractions was not desired, it was not necessary to construct the elaborate vacuum receiving apparatus given in Bulletin 490. Instead, an ordinary vacuum distilling head was affixed to the bottom of the metal condenser with a rubber stopper, and the distillate was collected in a 250-milliliter graduate fitted with a female ground-glass joint. Such a procedure needs volumetric rather than gravimetric measurements.

Materials

Ten petroleum oils and fractions were used to obtain the distillation data. Stocks No. 1, 2, 3, 4, and 6 were blends of kerosines, cracked and straight run gas-oils and furnace oils. Stock No. 5 was a reduced crude. Stock No. 7 was a kerosine. Stocks No. 8 and 10 were crude oils. Stock No. 9 was a fuel oil blended from waste of a number of runs.

Experimental Data

The experimental data, using the distillation procedure of the Bureau of Mines, are recorded in Tables 1-A and 1-B. In Table 1-A, the distillation data are recorded at cut points of cumulative volume per cents distilled for given cut temperatures. During the investigation, it became apparent the distillation results would be of greater value if the distillation data were recorded in terms of temperatures at cut points of cumulative 10 per cent increments distilled, where possible, as shown in Table 1-B.

Table 2 includes the distillation data obtained using ASTM Method D-158-41. The distillation temperatures are recorded at cut points of cumulative 10 per cent increments distilled. To prevent unnecessary gas loss, Stocks No. 8 and No. 10 were run with the condenser maintained at 32 F.

API gravities of all samples used were taken prior to all runs and are included with the distillation data for both methods.

Discussion of Results

Stocks were selected to give as widely varying distillation characteristics as possible. As shown in Table 2, the 10-90 slopes range from less than 2 to approximately 8 and the characterization factors (K)[3] extend from 10.6 to 11.9.

The slope is defined as the change in temperature per volume per cent distilled. In a temperature versus volume

TABLE 1-A. Bureau of Mines distillation procedure experimental data.

Stage 1 — Distillation at atmospheric pressure						
Stock number		1	2	3	3	6
Gravity, API		42.9	34.7	32.0	30.1	37.4
I.B.P., F		256	250	263	203	298
Vol. per cent Dist. for Frac. No. at Cut Temp., F						
1	122	.....	.....	.....	.....	.....
2	157	.....	.....	.....	.....	.....
3	212	.....	.....	.....	0.2	.....
4	257	0.13	0.20	.....	0.92	.....
5	302	1.35	1.0	0.82	2.2	0.35
6	347	9.6	2.8	2.4	4.5	4.6
7	392	27.8	7.3	21.8	9.2	17.4
8	437	52.6	16.9	47.3	17.0	28.2
9	482	73.8	29.5	64.0	30.8	40.4
10	527	90.9	51.5	79.8	48.4	55.0
Stage 2 — Distillation at 40 mm Hg.						
11	392	.....	72.5	88.4	70.0	67.2
12	437	.....	84.0	94.0	82.0	82.5
13	482	.....	89.6	97.0	89.5	89.8
14	527	.....	93.0	cracked	92.5	94.0
15	572	.....	95.6	.....	95.5	96.6
Residuum, per cent		8.7	1.9	0.8	1.2	1.3
Loss, per cent		0.4	2.5	2.2	3.3	2.1

†Abstracted from a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Chemical Engineering.

[1]The Texas Company, Port Arthur, Texas.
[2]University of Texas, Austin, Texas.

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TABLE 1-B. Bureau of Mines distillation procedure experimental data.

Stage 1 — Distillation at atmospheric pressure.					
Stock number	5	7	8	9	10
Gravity, API	17.0	43.1	33.0	36.5	36.7
I.B.P., F	215	252	105	203	93
10	455	347	245	350	214
20	482	371	307	389	284
30	514	394	402	418	381
40	.....	412	495	450	483
50	.....	429	.....	479	.....
60	.....	446	.....	508	.....
70	.....	463	.....	.....	.....
80	.....	481	.....	.....	.....
90	.....	506	.....	.....	.....
527 F BP, per cent	37.0	cracked	45.3	65.0	46.6
Stage 2 — Distillation at 40 mm Hg.					
10	.....	.....	.....	.....	.....
20	.....	.....	.....	.....	.....
30	.....	.....	.....	.....	.....
40	367	.....	.....	.....	.....
50	405	.....	405	.....	387
60	445	.....	495	.....	474
70	493	.....	.....	382	570
80	554	.....	.....	442	.....
90	.....	.....	.....	536	.....
572 F BP, per cent	85.3	.....	70.6	93.3	73.3
Residuum, per cent	12.6	3.0	26.3	3.6	23.7
Loss, per cent	2.1	2.0	3.1	3.1	3.0

TABLE 2. ASTM distillation — Method D-158-41.

Stock number	1	2	3	4	5	6	7	8*	9	10*
Gravity, API	43.0	34.7	32.0	30.1	17.0	37.5	43.0	33.0	36.5	36.7
I.B.P., F	331	356	358	238	280	345	340	147	289	129
10	374	437	393	426	485	402	371	263	382	237
20	391	467	407	460	516	423	391	326	408	300
30	408	492	423	486	535	452	400	403	432	378
40	423	515	435	509	562	481	414	499	456	477
50	437	532	453	530	596	512	430	595	483	565
60	453	550	472	551	.....	545	441	.....	512	.....
70	472	572	500	578	.....	575	457	.....	548	.....
80	492	606	536	613	.....	611	472	.....	605	.....
90	531	674	592	670	.....	661	495	.....	704	.....
F.B.P.	581	727	662	725	.....	708	522	.....	.....	.....
Recovery, per cent	96.0	95.0	96.0	96.5	53.0	97.0	97.0	51.5	93.8	51.5
Residue, per cent	2.0	4.9	2.0	2.5	44.0	2.1	1.8	45.5	3.8	45.5
Loss, per cent	2.0	0.1	2.0	1.0	3.0	0.9	1.2	3.0	2.4	3.0
K	11.9	11.7	11.2	11.4	10.6†	11.8	11.8	11.7†	11.7	11.9†
Slope 10–90	2.0	3.0	2.5	3.1	5.3#	3.2	1.6	8.3#	4.0	8.2#

* Run with condenser maintained at 32 F.
† Calculated from the ASTM 50 per cent temperature rather than the volumetric average boiling point.
# Calculated from the 10–50 slope as cracking prevented obtaining further distillation data.

per cent distilled plot, it assumes a straight line between the temperatures at the volume per cent distilled points selected. Characterization factor is defined as the cube root of the cubic average boiling point divided by the specific gravity at 60°/60°.

An investigation was conducted to determine the effect of the slope and characterization factor on a relationship between the two methods. It was found that the effect of K over the above ranges was negligible. A further study showed that if the data were plotted as temperature versus cumulative volume per cent distilled, the resulting curves tended to be symmetrical and that the sinusoidal property is reflected by both distillation methods. The sinusoidal property is a function of the slope of the distillation curve.

The above observations were found by previous investigators on formulating relationships involving analytical petroleum distillations of a similar nature. Geddes[4] related the 50 per cent temperatures of ASTM and true boiling point distillation data with six slope increments. Edmister[5] related ASTM, true boiling point and flash distillation data with a 50 per cent temperature and slope increment correlation. In a theoretical study, Okamoto and Van Winkle[6] related flash and true boiling point distillation data with a 50 per cent temperature and slope increment correlation.

Correlation

Trial and error has established that a relationship between the 50 per cent temperatures and a slope range increment of 10 per cent gives the best representation of the data obtained in this investigation. A 6 per cent increment was used for the 96-90 slope range-per cent as a 100 per cent distilled point could not be established with any accuracy.

The relationships are shown in Figs. 1, 2, and 3. Fig. 1 relates the ASTM 50 per cent temperatures to the Bureau of Mines 50 per cent temperatures for both Stage 1 and Stage 2 of the distillation. Fig. 2 relates the ASTM slope over the slope range-per cent indicated with the Bureau of Mines Stage 1 slopes. Fig. 3 relates the ASTM slope over the slope range-per cent indicated with the Bureau of Mines Stage 2 slopes.

The average deviation of the 50 per cent temperatures for the correlation of Fig. 1 is 4.2 F. The average deviation for both the 30 and 70 per cent boiling points, using Figs. 1, 2, and 3, is 4 F.

Calculation ASTM Distillation Data

ASTM distillation data can be calculated from Bureau of Mines distillation data by the following seven consecutive steps:

1. Plot the Bureau of Mines distillation data as shown in Fig. 4. The two discontinuous curves require three extrapolations in the following order:

a) Stage 1 527 F Extrapolation: Ex-

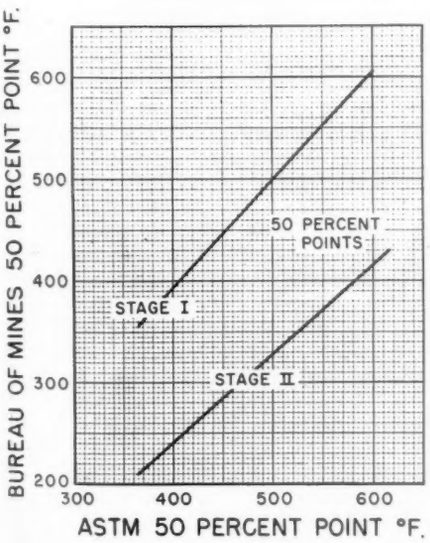

FIG. 1. Bureau of Mines vs ASTM 50 per cent boiling points.

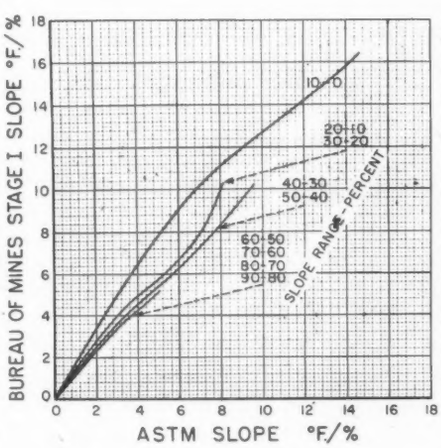

FIG. 2. Bureau of Mines stage I slopes vs ASTM slopes.

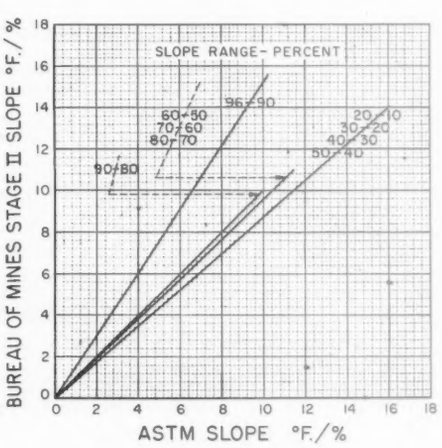

FIG. 3. Bureau of Mines stage II slopes vs ASTM slopes.

tend the Stage 1 distillation curve to the next highest volume per cent that is a multiple of 10.

b) Stage 2 Front Part Extrapolation: Extend the lower end of the Stage 2 distillation curve to the same volume per cent as in part a. This is the common per cent point.

c) Stage 2, 572 F Extrapolation: Extend the upper part of the Stage 2 distillation curve to the next highest volume per cent that is a multiple of 10.

2. Read the temperature of the Bureau of Mines 50 per cent point. Depending on whether it falls on the Stage 1 or Stage 2 distillation curve, read the ASTM 50 per cent temperatures from the corresponding line in Fig. 1. If the common per cent point is the 50 per cent point, read both values for the ASTM and take an average.

3. From Fig. 4, read off successive values of the temperatures at the 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 96 volume per cent distilled points for both the Stage 1 and Stage 2 curves for as far as the data extend.

4. Take successive differences of the temperatures obtained in Step 3 and divide by the volume per cent range. This gives °F/% slopes.

5. Using Figs. 2 and 3, read the ASTM slope for the slope range-per cent corresponding respectively to the calculated Bureau of Mines Stage 1 slopes and Bureau of Mines Stage 2 slopes.

6. Obtain the incremental ASTM temperature differences by multiplying the ASTM slopes from Step 5 by the differences of the corresponding slope range-per cent numbers; *i.e.*, 10 except for the 96-90 slope range-per cent, which is 6.

7. Start with the ASTM 50 per cent temperature calculated in Step 2 and successively subtract and then add the ASTM incremental temperatures calculated in Step 6 beginning respectively with the 50-40 and then the 60-50 slope range-per cent incremental temperature difference. This will give the ASTM temperatures successively for the 40, 30, 20, 10, and 0 and the 60, 70, 80, 90, and 96 volume per cent distilled points for as far as the data extend.

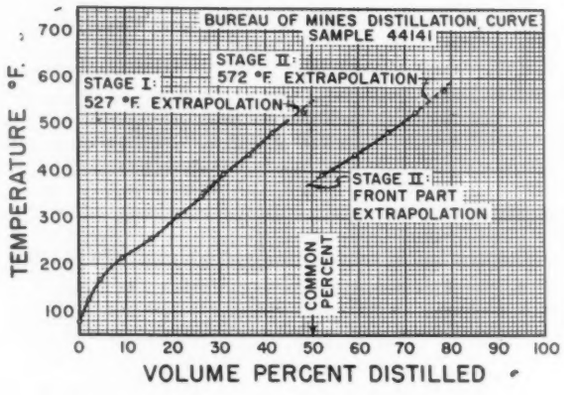

FIG. 4. Extrapolating Bureau of Mines data.

TABLE 3. Calculation of ASTM distillation data from Bureau of Mines distillation data.

Volume per cent distilled	Bureau of mines Temp. F	Bureau of mines Slope F/per cent	Slope range, per cent	ASTM Slope F/per cent	ASTM Diff. F	ASTM Temp. F
	Stage 1 — Distillation at atmospheric pressure.					
0	79					132
		13.8	10 – 0	11.4	114	
10	217					246
		7.4	20 – 10	6.5	65	
20	291					311
		9.1	30 – 20	7.6	76	
30	382					387
		8.6	40 – 30	8.3	83	
40	468					470
		8.1	50 – 40	7.9	79	
	Stage 2 — Distillation continued at 40 mm Hg.					549*
50	373					
		6.8	60 – 50	7.2	72	
60	447					621
		6.8	70 – 60	7.2	72	
70	509					693
		8.4	80 – 70	8.8	88	
80	593					781

* Average 50 per cent boiling point:

Stage 1: 50 per cent BP — from Fig. 5	548 F
Stage 2: 50 per cent BP — from Fig. 5	550 F
Average 50 per cent BP	549 F

Sample Calculation

Table 3 illustrates the seven-step procedure for estimating ASTM distillation data from Bureau of Mines distillation data. The Bureau of Mines data are from an oil designated as Sample 44141.[2] Step 1 is shown in Fig. 4 with the indicated extrapolations. Step 2 calculations are shown at the bottom of Table 3. The 50 per cent temperature is the common per cent point, therefore an average value was taken. Step 3 is shown in the second column, Step 4 in the third column, the corresponding slope range-per cent in the fourth column, Step 5 in the fifth column, Step 6 in the sixth column, and Step 7 in the last column.

Conclusion

One method of predicting anlytical distillation data for multicomponent hydrocarbon systems is the use of a key temperature point in conjunction with incremental slope relationships. Trial and error favors the 50 per cent temperature as the key point. This method favorably correlates Bureau of Mines and ASTM distillation data. The data used in developing the correlation cover crude oils and petroleum oil fractions with even distillation properties and characterization factors ranging from approximately 10.5 to 12. It would not apply to blends of highly fractionated cuts of different boiling ranges or highly aromatic fractions. The establishment of the Bureau of Mines distillation curve from ASTM distillation data, using the presented correlation, would not generally be possible. In the correlations of Figs. 2 and 3, the 10-0 and 96-90 slope range-per cent curves are based on rather widely scattered data points. No consistent correlation could be developed that would accurately predict these data points.

Acknowledgment

Acknowledgment is made to the Pan American Refining Company and the Humble Oil and Refining Company for their cooperation in supplying oils used in this investigation. K. K. Okamoto obtained some of the data presented.

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6. Okamoto, K. K. and Van Winkle, M. "Evaluation of Vacuum Flash Vaporization Curves From Atmospheric True Boiling Point Distillations." Petroleum Refiner *29*, 91-96 (1950), January.

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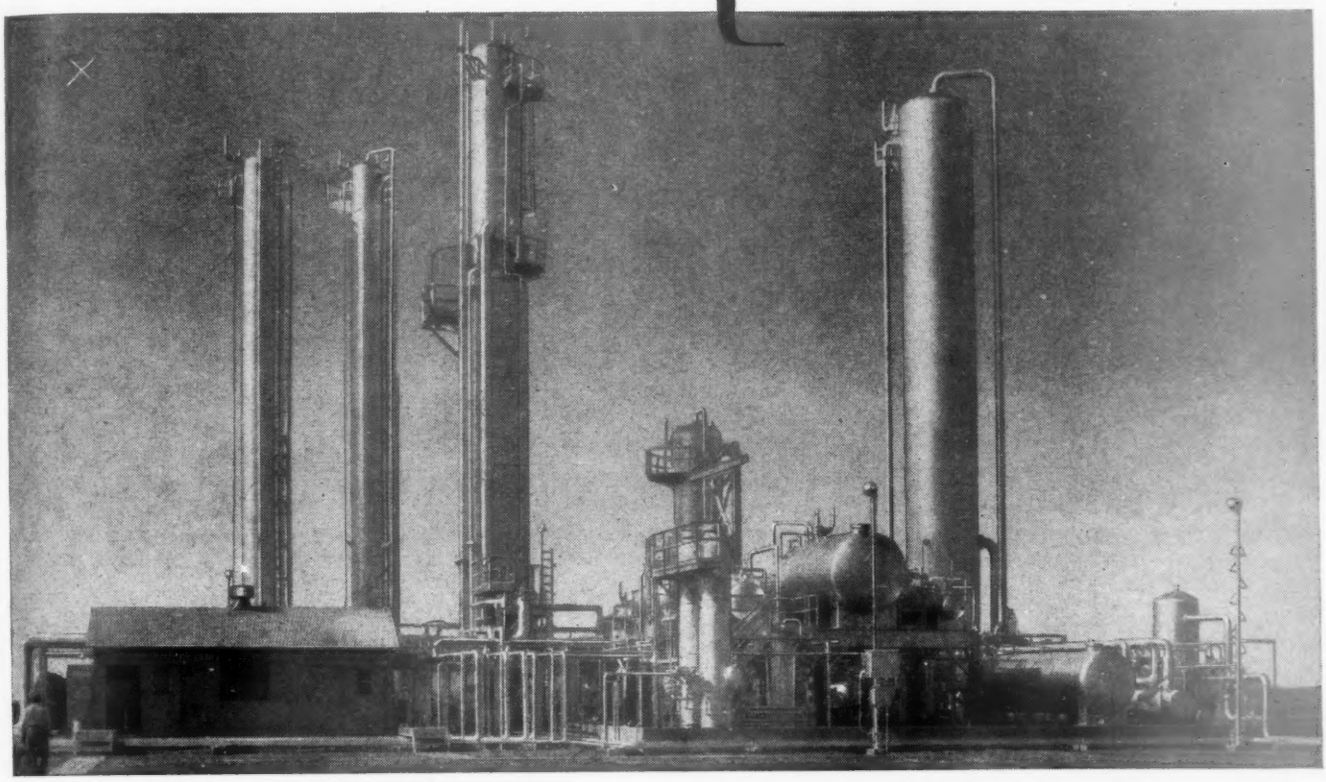

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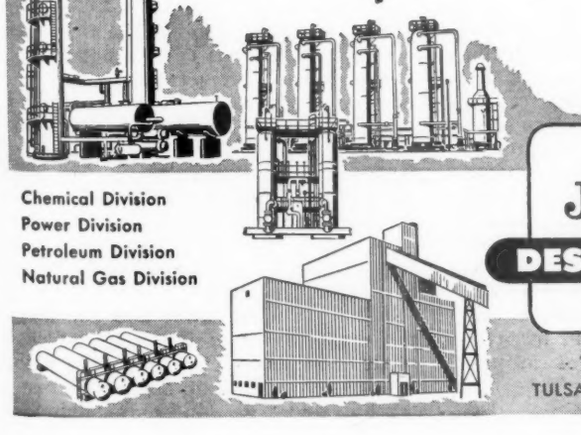

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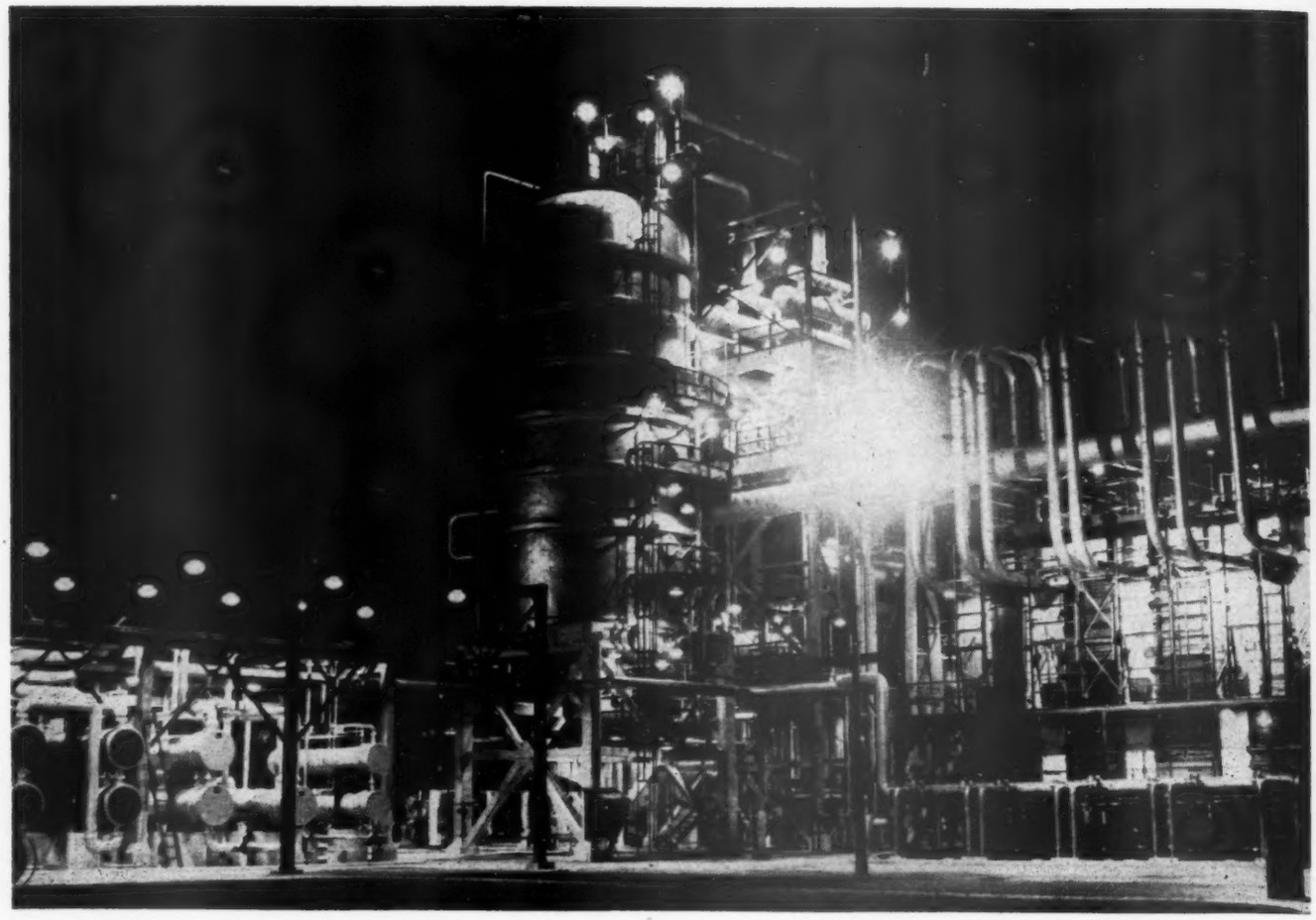

Vacuum unit from the northeast.

Trinidad Point-a-Pierre Refinery

A new cat cracker unit has been added to the Point-a-Pierre refinery along with new process units, and revamping of old ones

V. S. SWAMINATHAN

THE new catalytic cracking unit of the Trinidad Leaseholds, Ltd., was officially declared open by the Acting Governor of the Colony, the Hon. P. M. Renison on July 30, 1952. This ceremony marked the end of a two-year refinery modernization and expansion program at the Point-a-Pierre refinery.

In 1949 Trinidad Leaseholds, Ltd., in conjunction with their consultants the Universal Oil Products (UOP) Company of Chicago, worked out a scheme for the installation of new process units, revamping of existing ones and extension and addition of utilities to service the new equipment. These were calculated to bring the refinery up to date and to enable the company to compete in world markets on all petroleum products except lubricating oils and asphalts not currently manufactured by it.

It was necessary for the new refining units to be integrated with the existing refinery at La Carriere and with the former British Air Ministry refinery (which was known as the Western refinery) erected in 1940-41 for the production of aviation gasoline and which was subsequently purchased by the company. Before the modernization program the Point-a-Pierre refinery included crude distillation, thermal cracking, thermal reforming, sulfuric acid alkylation, isomerization, polymerization, and associated units for treatment of products and the manufacture of sulfuric acid and other chemicals used in the processes.

EXCLUSIVE

The process design of the new and revamped units was carried out by the UOP. Detailed engineering design, purchasing, shipment, and erection for the new process units was put into the hands of Foster Wheeler, Ltd., of London, who were the main contractors for the job. Engineering design, purchasing, shipment, and erection of the equipment for the revamp of existing equipment and for the services was carried out by Trinidad Leaseholds, Ltd.

The main units in the new construction comprised a vacuum unit, for catalytic cracking feed preparation, a fluid catalytic cracking unit, a gasoline treating unit and a gasoline re-run unit for

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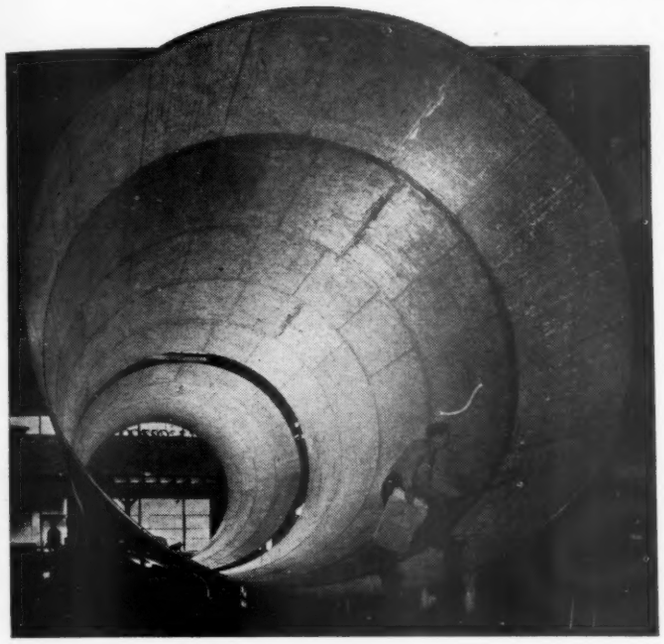

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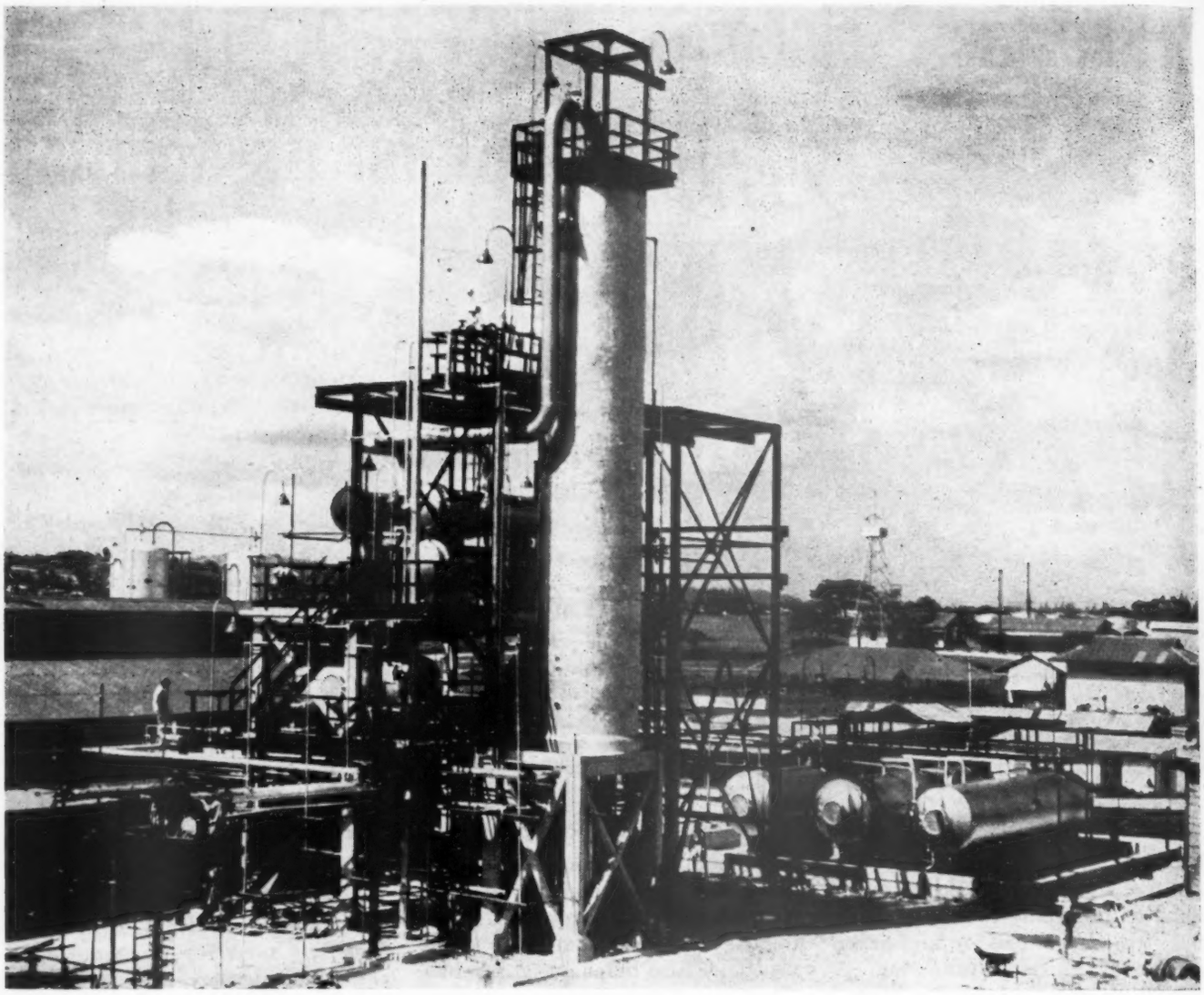


Rerun unit at the Point-a-Pierre refinery.

handling the cracked gasoline.

The company was requested by the British Government to hold the U.S. dollar expenditure to a minimum, and the value of the U.S. purchases amounted to 8 per cent of the value of the total materials; and the aggregate U.S. outlay, including charges for design, erection and materials, was less than 8 per cent of the erected cost of the work.

Many delays were experienced in the delivery of equipment both from the UK and the USA. To overcome this difficulty substitute and temporary materials were accepted in some cases, site fabrication instead of works fabrication was resorted to in others; and by modifying the site schedule and increasing the utilization of local labor over that planned during the later stages of the work, it was possible to complete the vital portions of the construction work according to the original time table. This is the first overseas project of this magnitude undertaken by Foster Wheeler, Ltd., to whom great credit is due for maintaining the original completion dates on the main units, in spite of the difficulties with which they were faced after drawing up the original program.

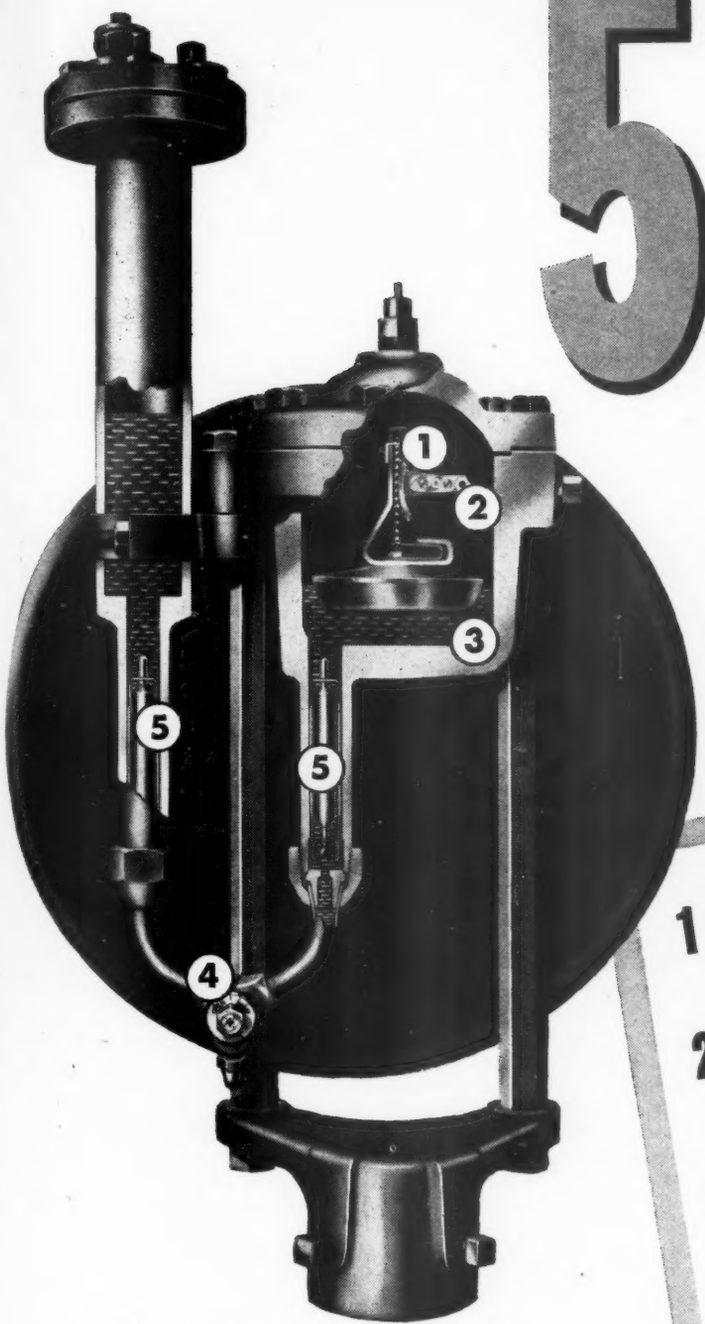
Work on the main units was carried out with a nucleus of six top American supervisors for the main contracts, some fifty British overseas supervisors and with local craftsmen and labor, which reached the peak figure of 1050 during the job. An extensive welder training program was inaugurated in the initial stages, and some 60 local employees were trained to do first-class welding for API / ASME Code requirements, to which Code all vessels in the refinery plant were constructed. Approximately 8500 tons of materials were shipped UK and USA for this job.

The first main unit to be commissioned, in April 1952, was the single column vacuum distillation unit having a design charge capacity of 25,400 bbl per stream day of topped crude, and producing vacuum gas oil, slop wax, and asphaltic bottoms products. To provide for possible corrosive crudes the 21 ft internal diameter fractionating column for this unit, which was field fabricated, was of Colclad steel, giving an internal lining of 7/64 in. of 13 per cent chromium. Colclad steel was also used for the 30-in. diameter transfer line. The fractionating column contains eight alloy decks and two alloy side-to-side pans.

An existing, redundant, reforming unit gas fired heater was dismantled, revamped, and re-erected on the new site to heat the charge for this unit. The first order for equipment for the vacuum unit was placed in March 1950, and the unit came on stream some 24 months later. The vacuum on this unit is maintained by a two-stage steam ejector with a jet type intermediate condenser. Waste heat from the vacuum gas oil is utilized both to raise steam at 200 psi and to pre-heat the charge to the unit. The vacuum unit has been designed to handle a wide range of crudes to cover the many types dealt with by the Trinidad refinery.

Gas oil from the vacuum unit is charged to the 15,000 bbl per stream day catalytic cracking unit designed by the UOP. This has an elevated reactor and pressured regenerator, and uses microspheroidal silica alumina catalyst. Products from the cat cracker are gasoline, light and heavy cycle oil, and gases containing C_3 and lighter hydrocarbons.

The reactor, regenerator, main fractionating column and catalyst storage hoppers for the catalytic cracker were



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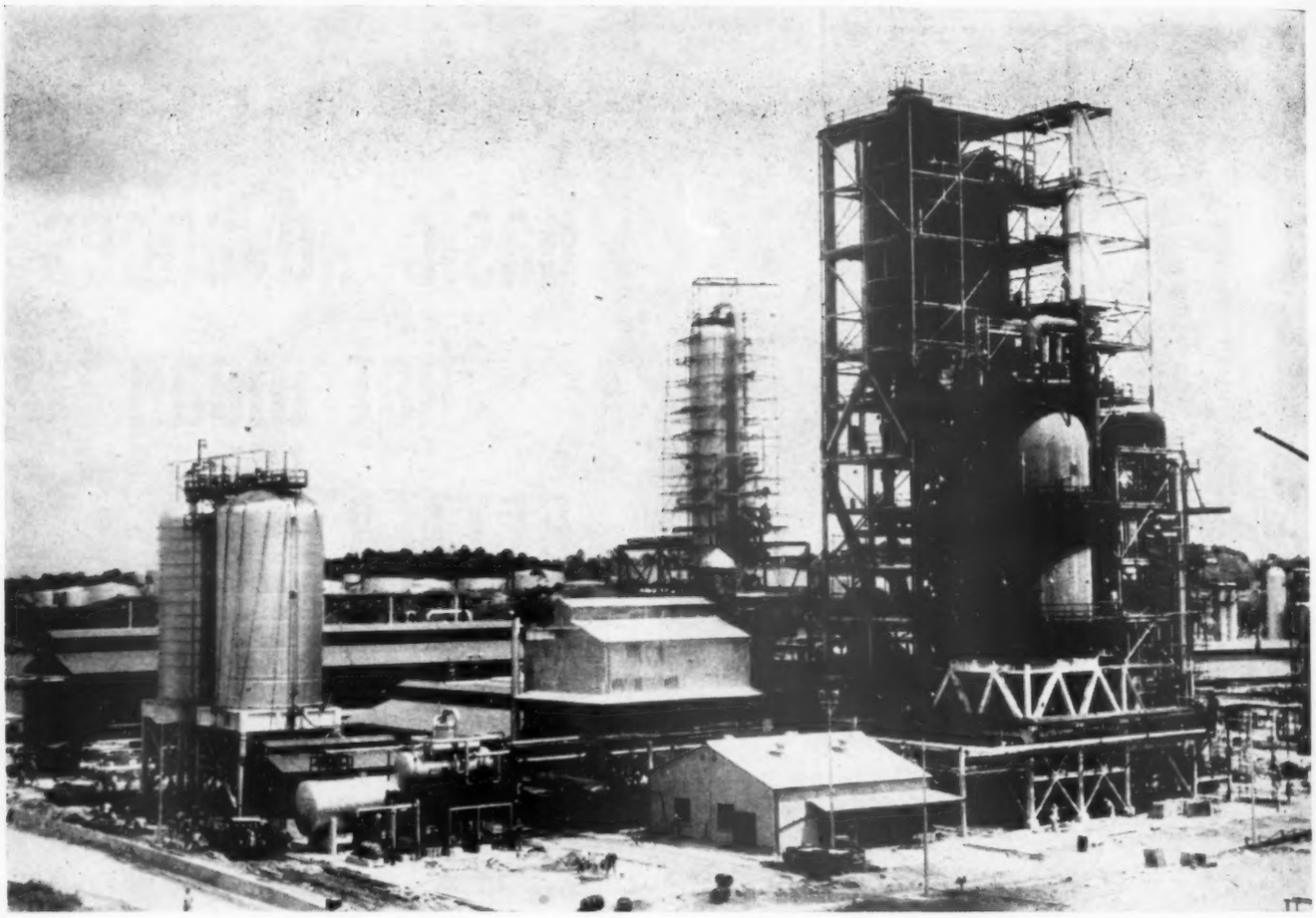

Catalytic cracker from the southeast.

shipped to site plate small, assembled in sections on the site and lifted in position by means of a 75-ton guy derrick. The largest of these vessels, the regenerator, is 31 ft 8 in. internal diameter, and 39 ft long, having a 7/8-in. wall and a 4-in. monolithic heat resisting concrete lining. The vessel is fitted with 6 two-stage cyclones for catalyst recovery from the flue gases.

The reactor is 23 ft internal diameter, and 35 ft long, having a wall thickness varying from 1¼-in. at the top to 1 9/16-in. at the bottom. This vessel was stress relieved, hammer tested and hydrostatically tested in situ, using hot gases from the air pre-heater for the cracking unit to provide the requisite heat for steam relieving. Five single stage cyclones are installed in this vessel for catalyst recovery from hydrocarbon vapors. The main fractionating column, 14 ft internal diameter and 97 ft long, has the lower 43 ft and bottom head fabricated from Colclad steel, while the 21 bubble decks and 6 disc and donut pan assemblies are of 12 per cent chrome steel. With the exception of the waste heat boilers, large 4/6 chrome catalyst piping, large expansion, and hinged joints and the refractory lining for the regenerator, all the major equipment for the fluid catalytic cracking unit was fabricated by British manufacturers, in some cases to American detailed drawings.

Gasoline from the cat cracker is split in a new fractionating column, which thus allows segregated treatment of light and heavy gasolines. The gasoline acid treating, caustic washing, and re-running units for handling cracked gasoline are of conventional design, the fractionating column being designed for vacuum operation at a charge rate of 3000 bbl per stream day.

Extensive revamping of the existing refinery equipment was also carried out. One thermal cracking unit was converted to combined topping and visbreaking operation, and another modified for visbreaking asphalt produced as a bottoms product in the new vacuum distillation unit. Improvements were effected to existing residuum flashing system to give greater flexibility and to handle the blending of vacuum pitch when this is not cracked. More efficient recovery of light hydrocarbons in the gas fractionating systems for the existing thermal cracking and reforming units has been arranged, and an additional hydrogen sulfide recovery system installed, from which approximately 6000 tons per annum of sulfur will be recovered. The fractionation of gases produced in the cat cracker is carried out in the revamped thermal reforming unit gas fractionation equipment.

In addition to these plant conversions, modifications and additions have been made to the plant services. A new induced draught cooling tower has been installed, a new Foster Wheeler 3 Drum type steam generator erected, considerable changes were made to the electrical distribution system and extra storage tanks and interconnecting pipe lines built.

Trinidad Leaseholds, Ltd., is the major producer of oil in this British West Indies island and it also purchases, as well as takes, substantial tonnages of crude from joint fields. It has plans in hand to import crude in sufficient quantity to utilize fully the new refinery facilities. The company is also manufacturing petrochemicals jointly with UOP.

Trinidad Leaseholds, Ltd., and the California Texas Oil Company, Ltd., each supply a 50 per cent share of the Regent Oil Company's requirements for the important U.K. market. The Caltex refinery at Bahrein already has a cat cracker in operation which was built during the last war. The completion of the Trinidad project puts both of these supplying companies in the position to provide the highest grades of products to the Regent Oil Company for this market. * * *

Recent operations of the company are summarized below:

	YEAR TO JUNE 30th 1952	1951	1950
Footage drilled†	206,900	184,800	180,000
Crude produced (bbl)†	7,243,000	7,300,000	7,375,300
Crude refined (bbl)‡	26,568,700	22,800,100	21,015,700

†For group account.
‡For own account and as agents.

The total area in Trinidad controlled by the group at the end of last June (excluding joint venture holdings) was 134,001 acres of which 132,096 acres comprised oil rights.

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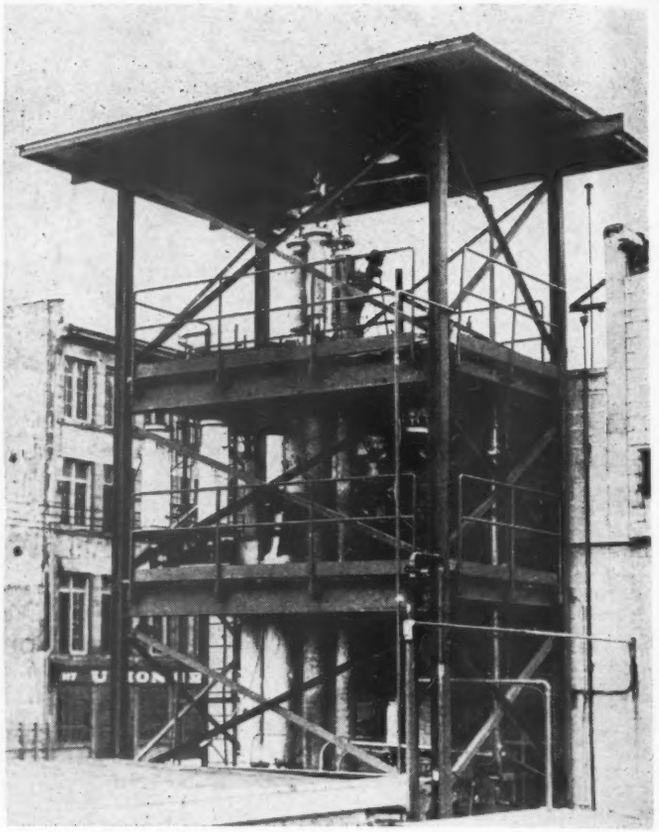
Instrumentation for the unit is simple and conventional, as indicated by this pilot plant panel.



View of ethylene oxide pilot plant.

New Ethylene Oxide Process

Direct oxidation method developed to manufacture important petrochemical intermediate via silver catalyst

ARCH L. FOSTER*

MANUFACTURE of the extremely important petrochemical product, ethylene oxide, by direct oxidation of ethylene over a silver catalyst in a "confined" fluid bed system is the most recent development in the effort to improve the synthesis of this material. The fundamental research work on this new process was carried out by Atlantic Refining Company's Philadelphia research and development department. Pilot plant work has been done by Vulcan Engineering Division, subsidiary of Vulcan Copper and Supply Company. The pilot plant was set up at Cincinnati, Ohio, and not only operating data and details covering design and process variables have been determined but the economics of the process, optimum yields obtainable, and similar information has been collected and the process is now being studied by a number of chemical and petrochemical companies for possible installations.

Fundamental principle in the operation of the process is the accurate and rigid control of temperature, and the prevention of "hot spots" that carry the highly exothermic reaction too far. The initial reaction is

$$2H_2C = CH_2 + O_2 = 2H_2C \begin{smallmatrix} O \\ / \quad \backslash \\ = \end{smallmatrix} CH_2$$

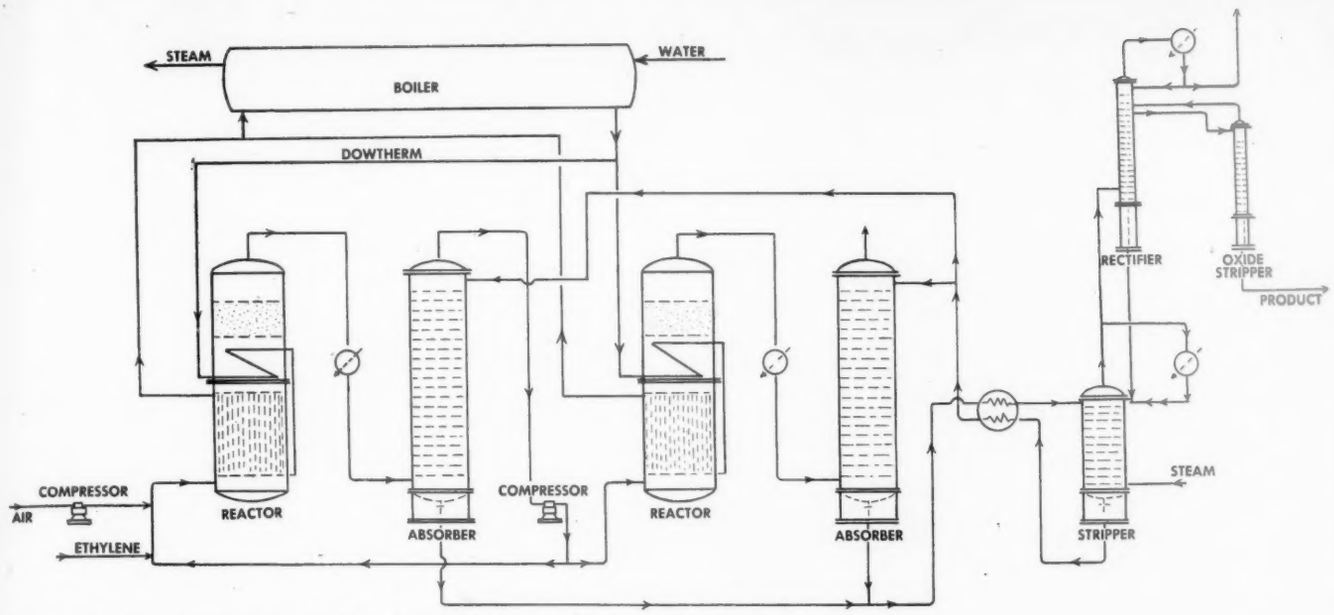
Ethylene — Ethylene Oxide

In this process the oxygen is obtained directly from air, mixed with the ethylene gas. If temperature is allowed to rise above the optimum, at any point in the reactor system, the oxidation reaction goes on to form as the right member of this equation, $4H_2O$ plus $4CO_2$, a contingency much to be avoided. Therefore in developing the design, Vulcan employed the fluidized bed system, now well known in the petroleum refining industry and being adopted rapidly by the chemical industry.

The "time of residence" of the ethylene-air mixture in contact with the catalyst is quite critical, therefore it is imperative that catalyst and charge be separated positively after the optimum contact time has passed. In the conventional fluid bed arrangement the catalyst particles can be mixed and remixed in any part of the reactor, and may be held in contact with a given portion of charge gas mixture for longer than the optimum period, resulting in a degra-

*Editor, Refining and Petrochemical Edition.

EXCLUSIVE



Simplified schematic flowchart of the Atlantic-Vulcan ethylene oxide process.

dation of the product to carbon dioxide and water and thus a lower yield and waste of ethylene.

Consequently, the reactor is designed as a large number of relatively small tubes through which the charge-catalyst mix is passed at the reaction temperature, and at such velocity that a minimum of the second, or carbon dioxide-producing reaction occurs. After emerging from the tubes the catalyst and the reaction product are separated, and the last traces of catalyst are removed from the reaction vapors by means of filters in the upper part of the reactor, above the tube sheet.

Following the major steps as shown in the accompanying flow chart, air is compressed and mixed with incoming ethylene gas of 95 per cent ethylene or higher, and the mixture is raised to 400-600 F and slightly above atmospheric pressure and then is introduced directly, through regulated orifices, into the lower end of each tube. The tubes contain a fluidized column of catalyst in the familiar finely divided state. They extend through the lower tube sheet and through the upper sheet, and on this upper sheet a layer of catalyst is maintained, which guarantees a controlled amount of catalyst in each tube. Above the upper, catalyst-covered sheet the reaction products and catalyst are separated, the entrained catalyst fines being removed from the gas stream by the porous alumina filter beds above. Little, if any, concentration of catalyst in these filters has occurred in pilot plant operations. Also, no need has appeared to regenerate the catalyst, a matter that reduces importantly the installation as well as the operating costs of the process. Cooling coils are installed above the tube sheet to "quench" the reaction quickly.

From the filter section the reaction gases pass through another cooler-condenser and into the bottom of the absorber tower, in which they meet counter-current a stream of water as absorbent and which extracts the oxide from the unreacted gases. This step may convert up to 50 per cent of the ethylene in the original charge. Absorber overhead vapors are recompressed and are sent through another and similar reactor assembly, where the oxide yield may be raised to as high as 70 per cent of the theoretical. These reaction gases are cooled, filtered, and cooled further, and are stripped of oxide in a second absorber column. Overhead extracted gases from this second absorber, mixed with bottoms from the stripper mentioned below, are returned to the two absorbers as overhead "reflux."

Recycle is obtained from the overhead vapors from the first absorber, which are returned and blended with the incoming raw charge ethylene to pass into the first reactor. Rich absorbent — water — bearing dissolved oxide is pumped to the stripper column, a bubble-tray unit, and the oxide is vaporized and driven overhead by steam, the temperature and amount of steam being regulated according to experience in the pilot plant for the most optimum and most economical use of the stripping steam. Overhead vapors from the stripper pass to the rectifier column, and to a conventional bubble tray unit, with part of the overhead stream returned to the stripper as reflux. Bottoms from this stripper pass through a reboiler and are combined with the second absorber overhead as mentioned above. Rectifier bottoms are sent back to the stripper as reflux and rectifier overhead is vented. A stream is drawn from the rectifier a few trays below the top and introduced into the top of the oxide stripper column, the overhead from which is returned to the rectifier, being largely carbon dioxide. The stripped oxide is sent to storage and, being inflammable and volatile (boiling at 51 F), is held as liquid condensate under an inert gas.

One feature of the system is the use of a cooling agent, Dowtherm, in the shell space around the banks of reaction tubes, of which several thousand may be employed in a commercial-sized reactor. In starting the plant, it is necessary to raise the catalyst temperature to the reaction level before synthesis can occur. The Dowtherm is heated in a gas-fired furnace, and is circulated around the catalyst tubes in the reactor until the temperature at which reaction is carried out is reached. The furnace is then shut down and the Dowtherm begins its function of absorbing heat from the components in the tubes, to maintain reaction at the desired rate and a temperature to minimize the formation of carbon dioxide and water. The heated Dowtherm is circulated through a heat exchanger type boiler, to produce either power or process steam, similarly to cool the Dowtherm and conserve heat. Catalyst may be made up for the process, in an individual unit designed for the purpose, and is introduced into the system by any means appropriate to fluid catalyst handling.

As may be seen from the view of the instrument panel in the accompanying figure (of the pilot plant unit) the instrumentation is typical and conventional. Flow and pressure regulators handle the main problems of controlling the reactor system and the different steps in product recovery. The instruments employed on the rectifying and stripping columns are typical for such fractionation-rectification equipment operations. Refrigeration is needed for the condensation and recovery of the oxide that must be provided for by special installation or obtained from a source common to other parts of the chemical plant, or refinery utilities. Electrical, steam, or gas power may be employed according to the best economics of the individual case as in any chemical or refining operation.

Reference Sources

1. Petrochemical Processes, Chem. Eng., Sept. 1952, page 161.

2. New Way to Ethylene Oxide, Chem. Eng., Feb. 1953, page 184.

3. New Process, Etc., Refiner, Feb. 1953, page 87.

4. Unpublished Communications, from Vulcan Copper & Supply Co.

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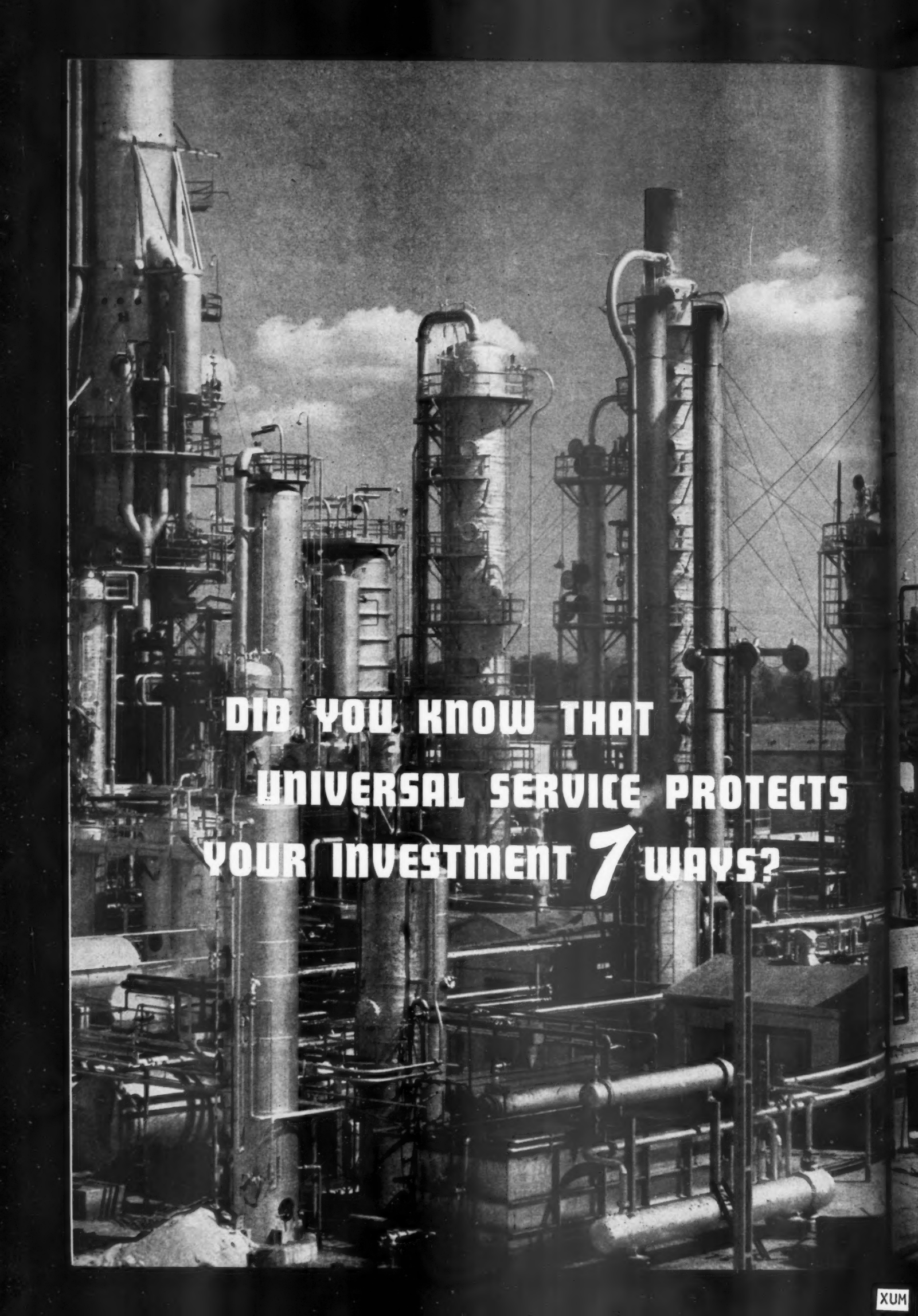
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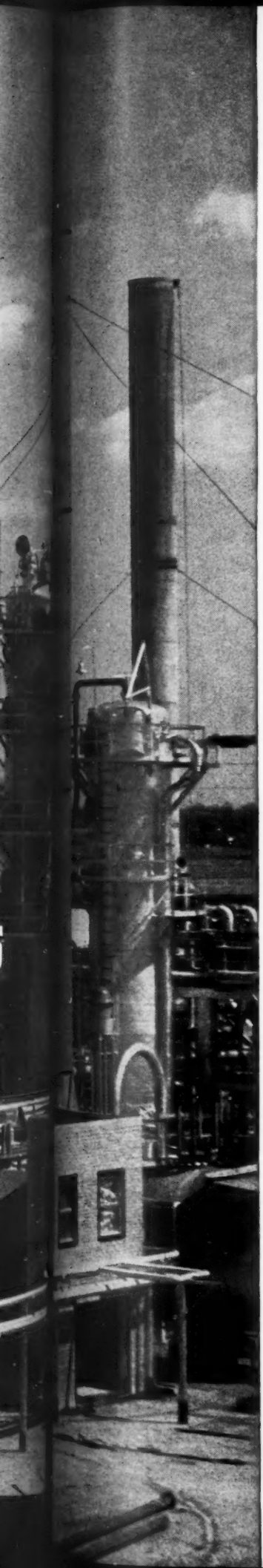

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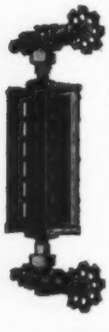

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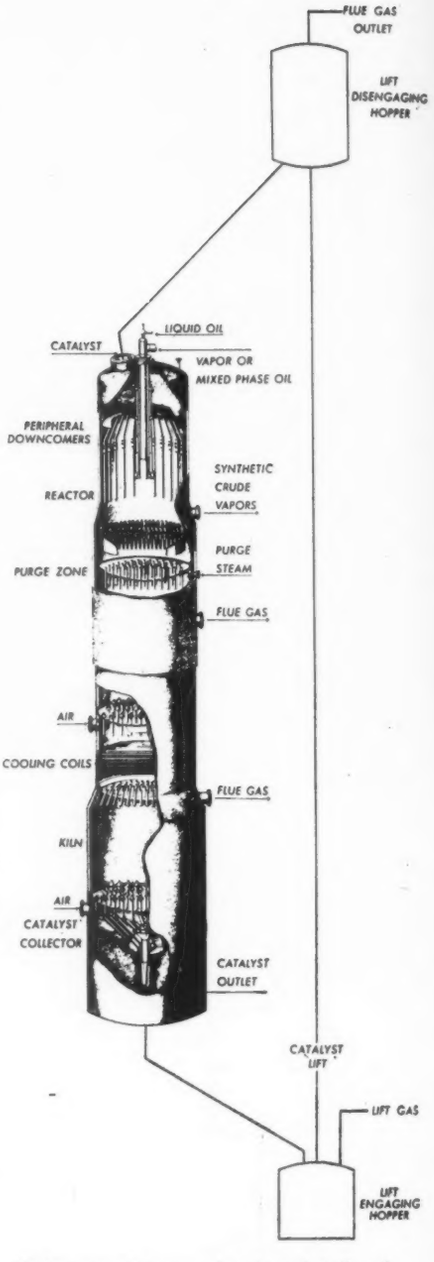
"Inside Story" of a Houdriflow Cat-Cracker



Cutaway diagram showing details of each step in the operation of a Houdriflow catalytic cracking unit.

In the Houdriflow cat-cracker of current design, the reactor is superimposed on the kiln in an integrated unit as shown in the cut-away drawing. Pelleted natural catalyst or spherical snythetic catalyst enters the top head of the reactor. Normally, 50 to 80 per cent of the catalyst enters the reactor by way of a flowing annular curtain, while the balance flows through peripheral downcomers that establish the bed depth.

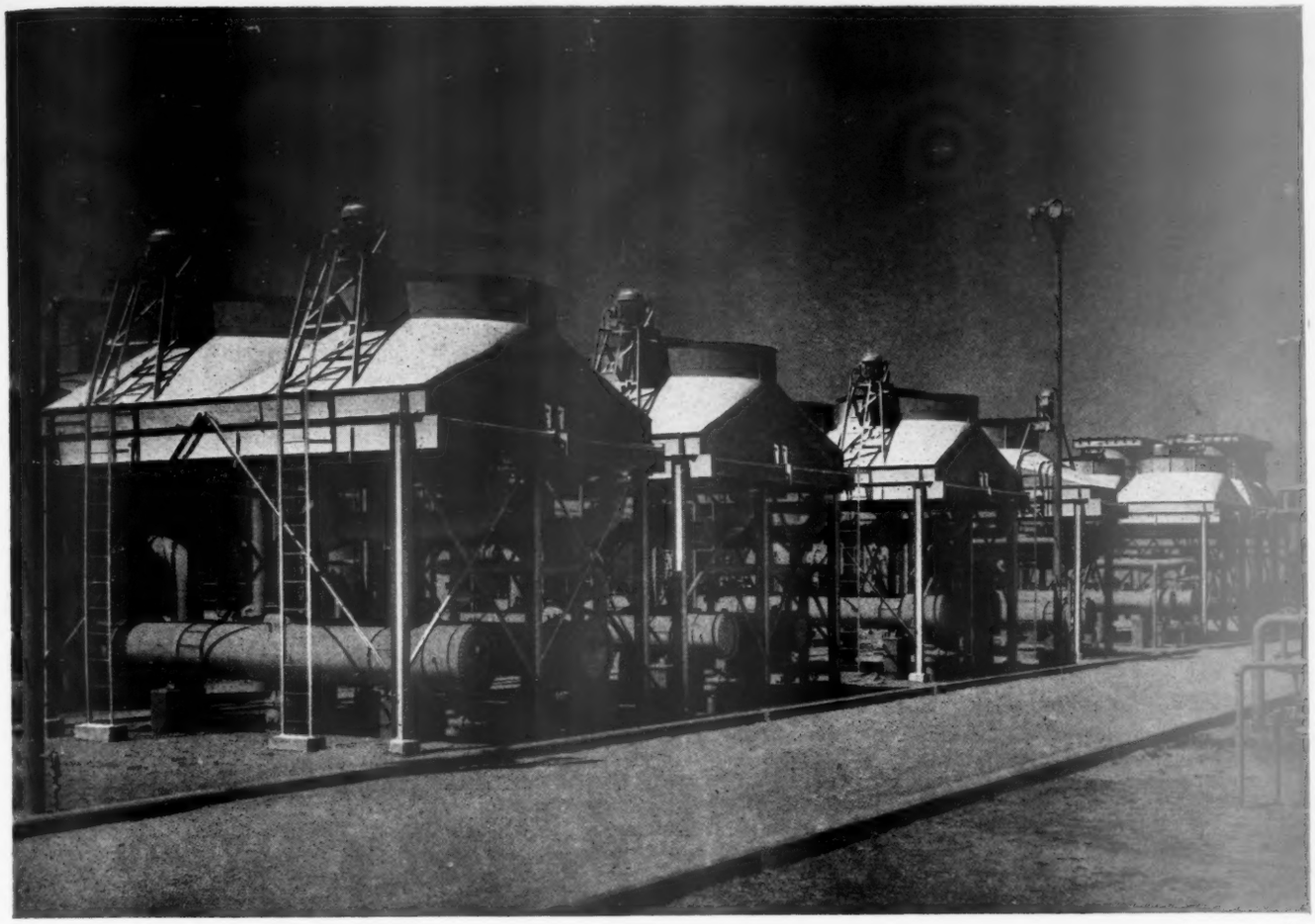
Liquid, vapor or mixed phase feedstock is introduced through a simplified nozzle situated centrally within the curtain of catalyst at the top of the reactor. This nozzle can spray a wide range of liquid-vapor mixtures onto the curtain of flowing catalyst. Vaporization and initial cracking occur when the charge contacts the catalyst. Cracking is completed as the hydrocarbon vapors flow downward through the solid moving bed reaction zone. After cracking, the vapors are separated from the catalyst in a disengager and flow to the synthetic crude tower. The catalyst is next purged with low pressure steam in a short purge section to remove residual oil remaining on the catalyst. The vaporized residual oil joins the main stream of cracked vapors and flows to the fractionating column.

Spent catalyst enters the kiln that operates at low pressures, where regeneration is accomplished by the countercurrent flow of air. From one to three burning zones are employed depending on the particular design requirements of the installation. In order to achieve accurate control of kiln temperatures, cooling coils are installed between the burning zones. Houdry identified this layer of hairpin coils as the "pancake" coil design. Water circulates through the coils at a high ratio compared to steam production, thereby providing effective control and maintenance of uniform catalyst temperature.

After flowing through the kiln, the catalyst is collected by means of an arrangement of concentric cones into a single line through which it flows to the lift engager. A mixture of flue gas and steam from the thermo-compressor lifts the regenerated catalyst to the top of the unit to complete the catalyst cycle. A distinct feature of the Houdriflow process is the control of catalyst circulation rates by lift operating conditions—thus eliminating the necessity of valve adjustments in the catalyst lines.

EXCLUSIVE

Houdriflow kilns and reactors have been designed to assure that flows of catalyst, oil vapors in the reactor, and air in the kiln are constant and uniform over the entire cross-section of each catalyst bed. Uniformity in distribution and contact time assures an optimum operation together with highest yields and quality of the cracked product. The quantity of catalyst deposit is essentially uniform on all catalyst particles. This facilitates regeneration control so that only catalyst regenerated to a consistently low residual carbon level is returned to the reactor. * * *



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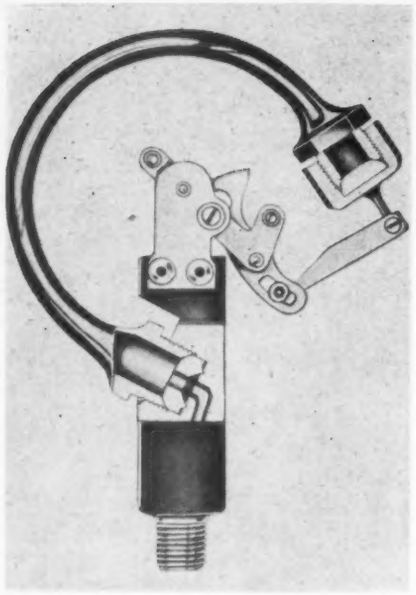


FIG. 1. Common Bourdon tube element employed in dial indicating pressure gages.

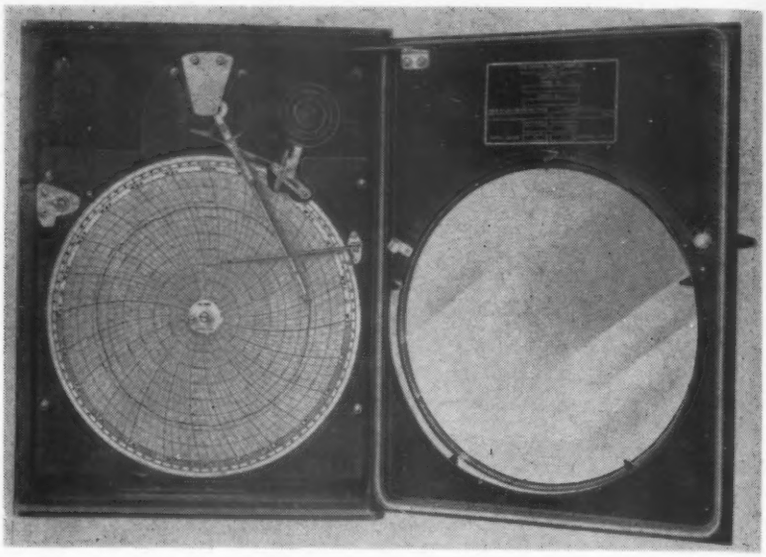


FIG. 2. Typical circular chart recording pressure gage usually board mounted in centrallized control room.

Trends in Refinery INSTRUMENTATION

PART 9--Selection, installation, and maintenance of pressure gages

S. D. ROSS* and W. W. DRAKE*

No one working in an oil refinery need be reminded of the value of pressure measurement and control in vessels, fractionating columns, and pipe lines. A typical refinery has literally thousands of the familiar round case dial indicators, from 4 to 6 in. in diameter with the simple Bourdon tube element (Fig. 1). In addition, hundreds of regular board-mounted recorders and recorder-controllers (Fig. 2) are employed as a part of centralized instrumentation for refinery processes—many with pneumatic transmission from locally mounted non-indicating, indicating, and often controlling units.

Because these common varieties are employed so extensively and because much can be written about their proper selection, installation, and maintenance, this article is devoted exclusively to them. Consideration is given to several types of primary elements beside the Bourdon tube, including the spiral, spring, and bellows. Much that is said regarding the use of these types, however, applies equally as well to pressure and vacuum measurements with electrical "transducers," which may find increasing use in refineries but which are today somewhat limited in their application.

Expression of Pressure Measurements

The bar graph of Fig. 3 clearly illustrates basic relationships between ways in which pressure measurements are commonly expressed. As shown, there are two reference points for measurements, namely (1) *atmospheric pressure* and (2) *absolute zero*. It is well-known that our surrounding atmosphere has a somewhat varying pressure of about 14.7 psi; as it is commonly measured with a column of mercury, it is often expressed in terms of the "head" of the mercury column which it will support—about 760 mm of mercury (mm Hg) or about 30 in. of mercury (in. Hg). This is a pressure above absolute zero pressure.

The Bourdon tube gage and other common types actually measure the difference between the pressure inside the process vessel or pipe line and atmospheric pressure, which acts on the outside of the pressure element. If the process pressure is greater than that of the atmosphere, the difference is called *gage pressure* (P_1 in Fig. 3). This same pressure can also be expressed as absolute pressure, which is obtained, as shown, by addition of the gage pressure to the atmospheric pressure.

For example, if the atmospheric pressure is 14.6 psi and the gage pressure is 16 psig the absolute pressure is 14.6

EXCLUSIVE

The Author

W. W. Drake, new co-author of our Instrumentation Series, is petroleum industry engineer in the Market Extension Division of Minneapolis-Honeywell. He is taking over the duties of John Procopi, who recently resigned his post at Honeywell to become advertising director for the Milton Roy Company.

A graduate of Harvard College, Drake was formerly associated with Philco Corporation in an editorial capacity. A part of his duties with Minneapolis-Honeywell will include co-authorship of this series of articles.

*Minneapolis-Honeywell Regulator Company, Industrial Division, Philadelphia, Pennsylvania.

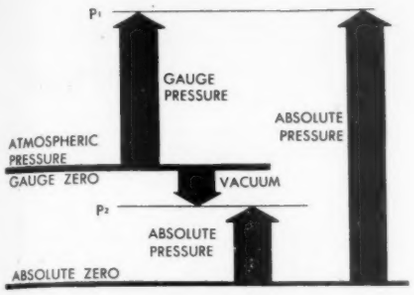


FIG. 3. Relationship between various methods of expressing pressure measurements.

TABLE 1. Pressure Equivalents.*

		Column of mercury (Hg)		Column of water (H_2O)	
Psi	Atm.	In.	MM	In.	Ft.
1	0.068	2.04	51.7	27.7	2.31
14.7	1	29.92	760	407.2	33.9
0.491	0.0334	1	25.4	13.6	1.13
0.0193	0.00132	0.0394	1	0.536	0.0446
0.0361	0.00246	0.0735	1.87	1	0.0833
0.433	0.0295	0.882	22.4	12	1

Example: To convert 15 psi to mm Hg: $15 \times \frac{51.7 \text{ mm Hg}}{1} = 775.5 \text{ mm Hg.}$

* Extractions from table in Chemical Engineer's Handbook, McGraw-Hill Book Company.

plus 16 or 30.6 psia. Because atmospheric pressure can vary and because absolute pressure differs from gage pressure by this amount, it is obvious that statements or logs of pressure measurements should always have the units specifically given as being "gage" or "absolute."

As also shown in Fig. 3, pressures below atmospheric are expressed as *vacuum* if the gage measures the difference from atmospheric pressure (P_2 in Fig. 3). This same pressure can also be expressed as absolute pressure by subtraction of the vacuum reading from atmospheric pressure. Vacuums are often expressed in inches or millimeters of mercury; for example, if atmospheric pressure is 764 mm Hg and the gage reads 50 mm Hg vacuum, the absolute pressure would be 764 minus 50, or 714 mm Hg absolute.

Medium and high pressures are usually expressed in psig units but high pressures are sometimes expressed as atmospheres, one atmosphere being equivalent to 14.7 psi. Lower pressures, both gage and vacuum, are sometimes given in "inches of water" as well as "inches or millimeters of mercury." Table 1 above gives conversion factors for the more commonly used units.

Need for Absolute Pressure Gage

Distinction between measurement of gage and absolute pressure, given in the above definitions, serves to introduce one important selection factor, namely: Possible need for compensation against the affects of atmospheric pressure. Although in most refinery applications it is entirely adequate to measure and control from gage or vacuum measurements, an example will show where absolute pressure should be the measured value.

Assume that the desired product quality is obtained in a fractionating column when the vacuum is 28 in. of mercury, based upon an atmospheric pressure of 30 in. Hg. Under these conditions the back pressure in absolute units should be two inches of mercury or 50.8 mm. Assume now that the atmospheric pressure changes during operation by plus 0.2 in. Hg, or 5.08 mm, which is not an unusual change. With an ordinary vacuum gage used to control column pressure, the increase in atmospheric pressure would result in an equivalent increase in the gage reading, as the gage measures the difference between this pressure and the column pressure.

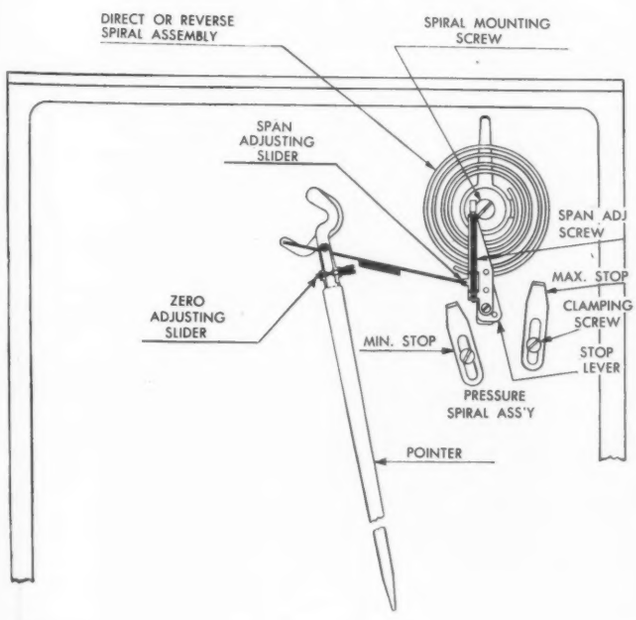
Such a measurement would therefore initiate control action to decrease the vacuum (increase the absolute pressure) by 5.08 mm—a change of 10 per cent from the desired value of 50.8 mm Hg absolute. Actually, to maintain the product quality, corrective control action should be called for by the instrument only when the column back pressure changes. An absolute pressure gage, which automatically compensates for changes in atmospheric pressure, is therefore required, unless the operator makes frequent barometer readings and adjusts the set point of the controller each time a change occurs. The effects of such changes are obviously greater, percentagewise, when lower absolute pressures are being measured.

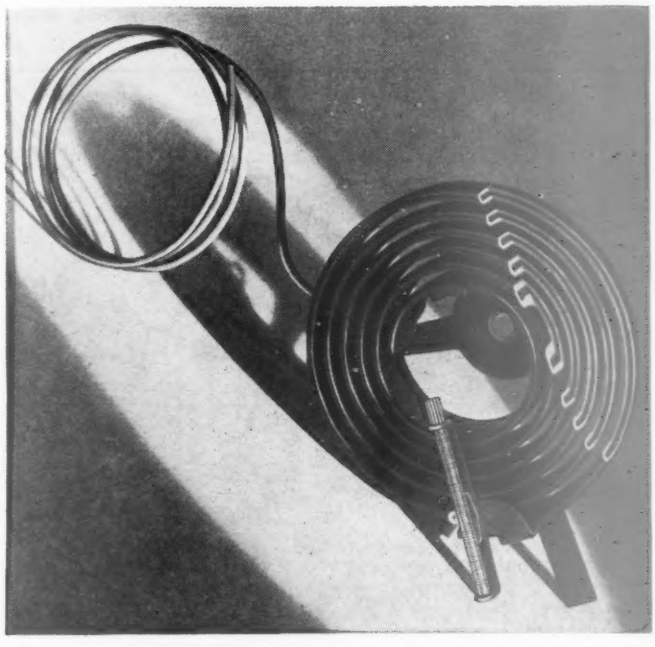
Selection of Gage

Two important factors must be considered in the selection of a pressure gage, namely: (1) the range of pressure it is to cover and (2) the material of construction of the element to suit the process fluid. In addition, of course, selection must be made of the type of indication, recording, transmitting, and controlling functions desired.

For optimum accuracy and sensitivity, a gage range should be selected so that the normal working range is between 40 and 60 per cent of the maximum range of the gage. In the small dial indicators employing Bourdon tubes, certain commonly used ranges are usually selected and standardized upon so that these gages can be carried in stock for quick installation or replacement. In one typical refinery the

FIG. 4. Spiral element — schematic diagram and cut-away view.





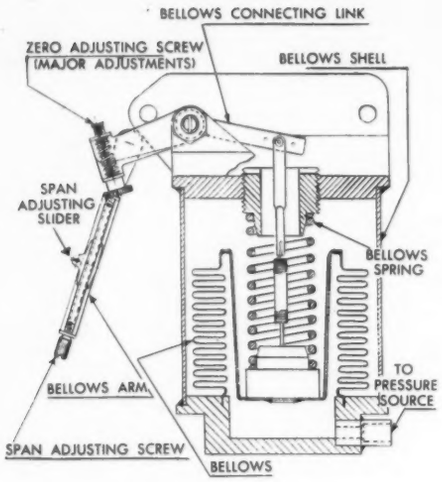
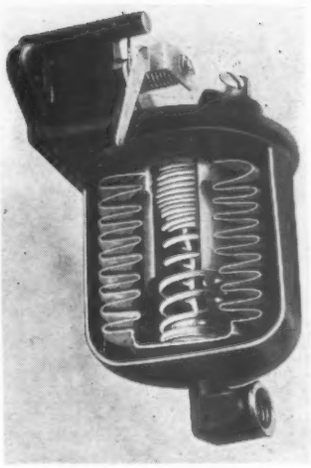


FIG. 5. Spring-and-bellows element for pressure and cut-away view.



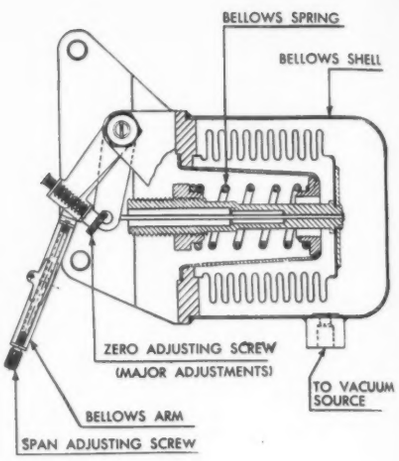
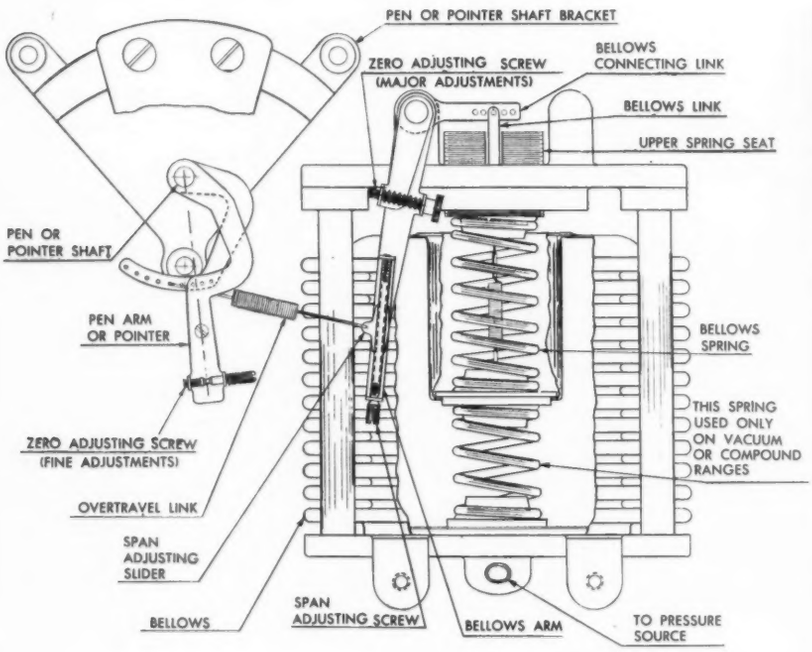


FIG. 6. Spring-and-bellows element for vacuum.



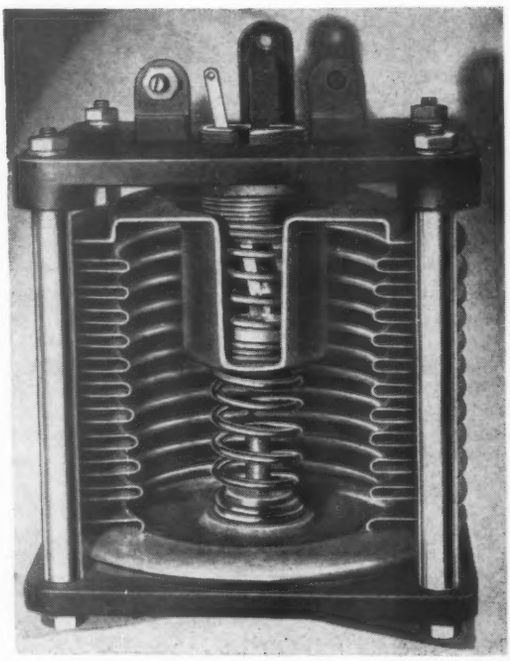
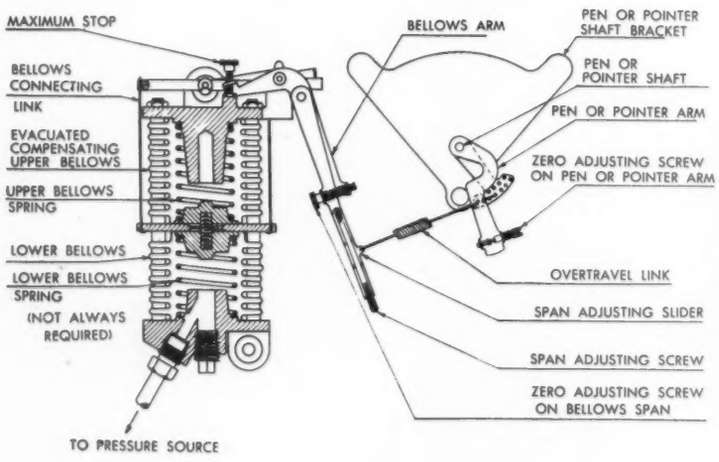


FIG. 7. Low range spring-and-bellows element — schematic diagram and cut-away view.



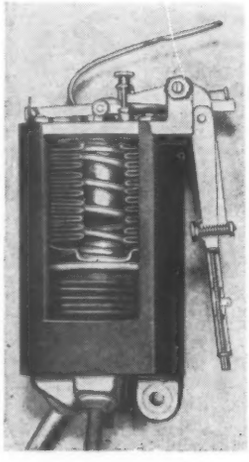


FIG. 8. Absolute pressure-schematic diagram and cut-away view.

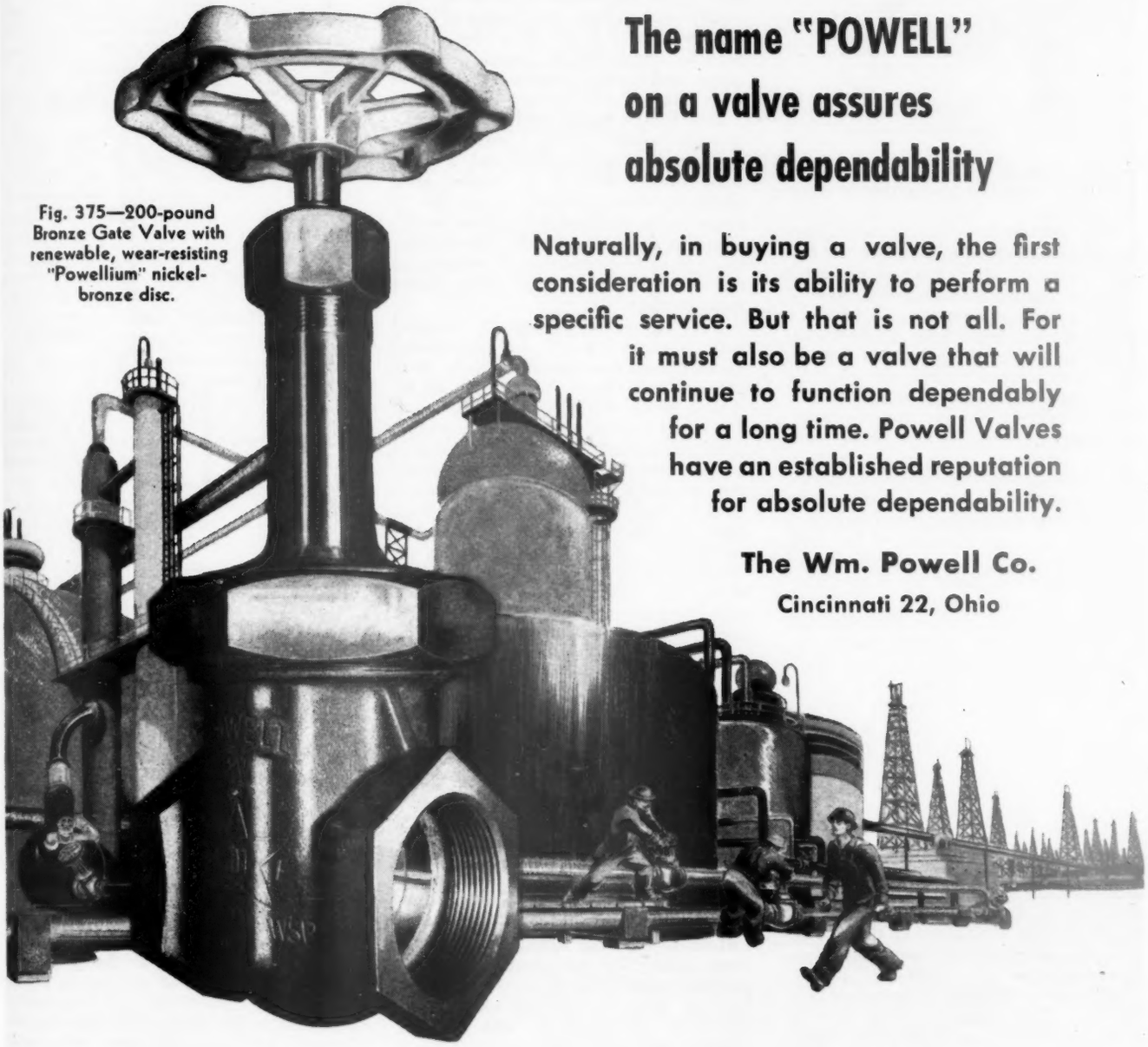


Fig. 375—200-pound Bronze Gate Valve with renewable, wear-resisting "Powellium" nickel-bronze disc.

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TABLE 2. Ranges of dial-type Bourbon gages standardized upon for a typical refinery.

Bronze tube	Steel tube
30 in. Hg – 60 psi	30 in. Hg – 100 psi
0–30 psi	0–30 psi
0–100	0–100 psi
0–200	0–200 psi
0–300	0–300 psi
0–600	0–1000 psi
0–1000	0–3000 psi

ranges given in Table 2 were found to meet the needs and are carried in warehouse stock.

This refinery uses bronze tube gages on all steam, water, and air service, and also with any other fluid if advisable from a corrosion standpoint, and if fluid is non-inflammable. Steel tube gages are employed with all hydrocarbons, including all petroleum liquids, fuel gases, and oil vapors. Occasionally they find it necessary to ignore the recommendation for keeping the working range between 40 and 60 per cent of the maximum range of the gage in order to adhere to their range standards.

For greater sensitivity and accuracy in conventional indicating, recording, and controlling pressure gages of the type illustrated in Fig. 2, spiral, bellows, and similar type elements have been designed. The exact ranges of such elements and specific designs vary with the manufacturer but typical limits for units illustrated (Figs. 4-8 inclusive) are summarized in Table 3.

Spirals: The spiral (Fig. 4) employs the well-known Bourdon tube principle, gaining additional movement and power from the increased length of the flattened hollow tube. The end free to move is connected to a pen or pointer at the calibration slider as shown. Spirals are available in a sufficient number of sizes to make overlapping ranges available over the complete usable span of this type of element; there is therefore practically no limitation in the choice of range, except the minimum and maximum limits given in Table 3.

Spring and Bellows: Elements of this type essentially comprise a bellows with spring arranged to act against the force due to pressure or vacuum acting on the bellows. In the design for gage pressure (Fig. 5), pressure is applied inside the bellows so that the bellows is expanded against the spring. In the design for vacuum, (Fig. 6), the vacuum is applied outside the bellows, which is contained in a sealed shell so that the bellows tends to expand against the spring. In both designs the assembly is arranged to cause the pen arm or pointer to move upscale with increasing pressure or vacuum.

Range of the spring-and-bellows element is easily changed by removal of the spring and installation of a spring with a different gradient. For ranges of 0-100 in. of water to 0-15 psi, a bronze bellows is employed in Brown pressure gages, and for higher ranges the bellows is of stainless steel.

Low Range Spring-and-Bellows: The assembly shown in Fig. 7 was designed for lower pressure ranges with a phosphor bronze bellows of larger area which develops greater power for its range. As in the case of the other design of spring-and-bellows units, the calibrating spring is external and therefore can not be corroded by the fluid under measurement.

This type element can be supplied with vacuum ranges, or compound vacuum and pressure ranges. In such cases an additional spring must be installed inside the bellows as illustrated. To change the range of a vacuum or compound range unit, a new bellows assembly and new external spring is required; the internal spring is made of stainless steel to resist corrosion. Because of its size, this element assembly is mounted on the back of the instrument case.

Absolute Pressure Element: As shown in Fig. 8 the element for absolute pressure measurements essentially comprises two spring-and-bellows assemblies, one over the other. The upper bellows is evacuated and sealed at a nearly prefect vacuum. It acts much as an aneroid barometer to compensate for changes in atmospheric pressure so that the lower bellows, connected to the process can be calibrated to read absolute pressure regardless of changes in atmospheric pressure.

For absolute pressure measurements above the maximum range of this element (30 psi) differences of atmospheric pressure from the normal 14.7 psi represent a small percentage of the full scale span and spiral elements are often employed, calibrated in absolute pressure units (pen or pointer is set at 14.7 psi with no pressure on the element). In an instrument with a spiral element calibrated 0-60 psi absolute, a change in atmospheric pressure of one inch of mercury, which is rare, will introduce an error of less than one per cent.

Installation of Gages

Of equal importance to the selection of the proper range and material of construction for the element of the pressure gage is its installation. Due consideration must be given to the location of locally mounted gages as well as to the installation of piping from the pressure measuring point to the instrument. Locally mounted gages should be placed, wherever possible, so that they can be easily read.

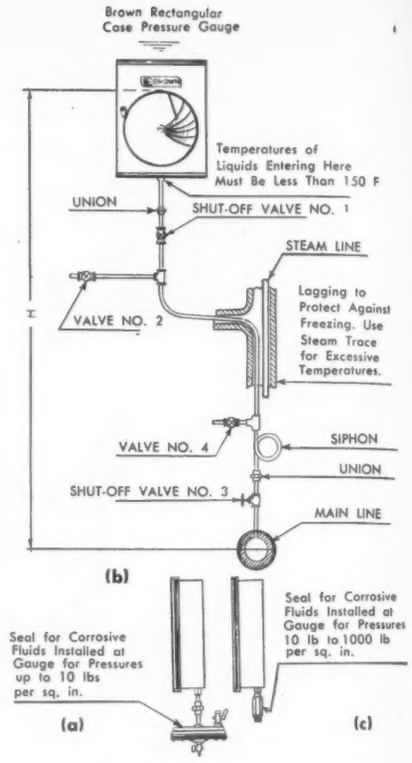
Brown Rectangular Case Pressure Gauge
Temperatures of Liquids Entering Here Must Be Less Than 150 F
UNION
SHUT-OFF VALVE NO. 1
STEAM LINE
Lagging to Protect Against Freezing. Use Steam Trace for Excessive Temperatures.
VALVE NO. 2
VALVE NO. 4
SIPHON
UNION
SHUT-OFF VALVE NO. 3
MAIN LINE
(b)
Seal for Corrosive Fluids Installed at Gauge for Pressures 10 lb to 1000 lb per sq. in.
Seal for Corrosive Fluids Installed at Gauge for Pressures up to 10 lbs per sq. in.
(a)
(c)

FIG. 9. Piping arrangement for pressure gage installation.

Installation of Piping. Piping or tubing to the gage should be about ½-in. OD by ⅜-in. ID but pressures less than one psi required tubing having ½-in. ID minimum. Smaller piping than these recommendations should be avoided particularly where there are long lengths of connecting tubing to the gage because of the increased measuring lag it would cause. To reduce the possibility of leaks, copper tubing and compression fittings are recommended, wherever feasible.

When corrosive fluids are measured with a bronze element, and where necessary with other elements, an oil seal should be placed in the gage line directly below the instrument as shown in Figs. 9a and 9c for pressures below and above 10 psi, respectively. The seal is filled with a light, clear oil—such as SAE No. 10. (No seal can be used with gages having ranges lower than 75 in. of water).

Gages measuring steam pressure require a siphon in the line, as shown in Fig. 9b. The siphon should always be installed close to the steam main as illustrated. In general, the maximum temperature of hot fluids entering the gage element must not exceed about 150 F.

For installations where there are pulsations or rapid pressure changes, the pulsation peaks can be absorbed and an

TABLE 3. Ranges for typical pressure elements — spiral, etc.

Type of element	Minimum range	Maximum range
Spiral (Fig. 4)		
Bronze	0–18 psig	0–15 psi vacuum (0–400 psig)
Steel	0–30 psig	0–4000 psig
Stainless steel	0–50 psig	0–4000 psig
Spring and bellows for gage pressures (Fig. 5)		
Brass	0–90 in. H_2O gage	0–16.3 psig
Stainless steel	0–15 psig	0–40 psig
For vacuum (Fig.6)	0–15 psi vacuum	0–30 in. Hg, or 15 psi vacuum
Low range spring and bellows (Fig.7)	0–5 in. H_2O vacuum or gage	0–90 in. H_2O vacuum or gage
Absolute press element (Fig. 8)	0–100 mm Hg abs.	0–60 in. Hg abs. (29.47 psi)

average pressure reading obtained by means of a pulsation check available from most instrument manufacturers or other sources. Not only does such dampening make an average reading possible, but also it saves wear on the element and, in the case of a recorder, provides a better chart record.

A union connection placed in the pressure line will aid in mounting the instrument. A shut-off valve should be installed ahead of the union so that the instrument can be removed from service (Valve 1 in Fig. 9b). It is also recommended that a tee be installed in the line as shown in Fig. 9b so that a second gage can be connected in parallel with the installed gage for checking purposes. A shut-off valve (2 in Fig. 9b) is of course required in this branch line.

Placing the Gage in Operation. After all piping connections have been made, the gage can be placed in operation. Normally it can be assumed that a new gage has been accurately calibrated and checked before shipment and no adjustments should be made except as outlined below:

Measuring pressure of clean liquids and gases: The complete installation for such fluids is illustrated in Fig. 9b, except that the siphon and Valve No. 4 are not required. Procedure for starting instrument operation is as follows:

(a) With Valve 1 closed, Valve 2 and then Valve 3 are opened to blow dirt out of line.

(b) When line is clear, Valve 2 is closed then Valve 1 is opened. The instrument is then indicating or recording the pressure.

Measuring steam pressure: For steam a siphon is required as shown in Fig. 9b. Procedure for starting instrument operation is recommended by either of the following methods:

(a) With Valve 1 closed, Valve 2 and then Valve 3 are opened to blow dirt out of line, and then Valve 2 is closed. Steam is allowed to condense and fill the tubing and siphon. Then Valve 1 is opened to place the instrument in service.

(b) An alternate method of filling the piping and siphon is to close Valves 1 and 3 and open Valves 2 and 4. A hose is attached to Valve 4 and water is forced through the line until all the air is expelled from Valve 2. When clear water is discharged through Valve 2, Valves 2 and 4 are closed; then Valves 1 and 3 are opened to place instrument in operation.

Correction for Liquid Level in Lines. Pressure gages having the connecting lines completely filled with liquid would be in error by the head of liquid in the tubing if this is not taken into account—the direction of the error depending upon whether the instrument is installed above or below the point of measurement. *If the instrument is installed above*, the gage must be corrected for a low reading by an amount equivalent to the head "*H*" in Fig. 9b. *If the instrument is installed below*, the gage must be similarly corrected for a high reading.

To correct a head affect error, the amount of the error must first be determined in the units for which the gage has been calibrated (see Table I for pressure equivalents). With liquids other than water the specific gravity enters into this calculation. For example, the correction for gages calibrated in psi is: Height of fluid *(H)* time specific gravity of fluid times 0.443 (a constant equivalent in psi for one foot of water).

If the necessary correction, plus or minus, is less than 10 per cent of full scale, it is made by turning the zero adjusting screw located at the top of the pen arm or pointer, until the reading is correct (zero when no pressure is connected to element.) On control instruments and where the error is greater than 10 per cent, the method of correction depends upon the type of element employed, and the recommended procedure becomes a bit too involved to cover in an article of this length (see manufacturers instructions).

Rather than calculate the head error in an installation, a test gage can be installed at the pressure connection and the measuring gage reset to read the same as the test gage. Where large compensations for head would be necessary, some refineries prefer to use pneumatic transmitters at the pressure connection.

On installations where gage piping is quite long and the pressure connection is at a much higher elevation than the gage, a seal pot is sometimes used at the pressure connection. The piping and seal pot are then filled with water, or in some cases 50-50 water and glycerine. This system insures a definite hydraulic head that does not easily change and that can be readily compensated.

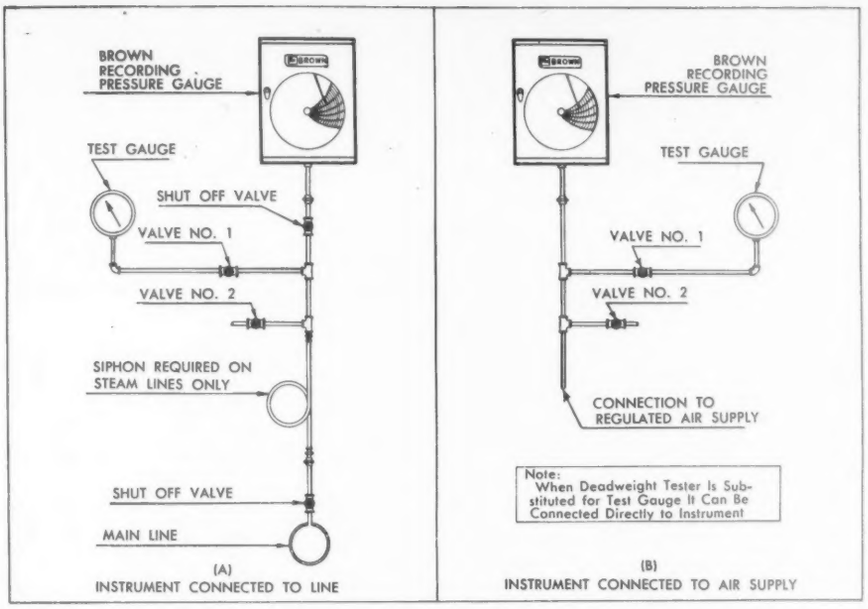

FIG. 10. Methods for pressure gage calibration (a) instrument connected to line and (b) instrument connected to air supply or dead-weight tester.

Checking Calibration

There are four methods of checking the calibration of pressure gages in the field, namely:

(1) Zero adjustment.

(2) Single point and zero check.

(3) Displacement or "dead weight" tester.

(4) Standard test gage and regulated air supply.

In addition to these, a fifth method will be described for absolute pressure gages.

Zero Adjustment. Often the calibration shift of a pressure gage is constant and can be corrected by opening the system to atmosphere and resetting the pen or pointer to zero (this method is not applicable to "suppressed range" gages that should be adjusted by method 3 or 4). Errors in zero reading of the instrument are corrected in an identical manner to that described above for head errors.

Single Point and Zero Check. This method is particularly applicable for calibrating a pressure gage that normally operates at a known pressure. A typical installation for checking an instrument by this method is illustrated in Fig. 10a. The instrument need not be disconnected from the process vessel or pipe line.

The procedure for this method is as follows:

(1) The shut-off valve is closed and Valve 2 is opened, venting the system to atmosphere.

(2) A zero adjustment is made as previously described.

(3) A test gage is connected to Valve 1 as shown and Valve 2 is closed.

(4) The shut-off valve is opened, allowing process pressure to enter the system.

(5) If the calibration is not within ± 1 per cent of full scale, it is readjusted by means of the span adjusting screw (see Figs. 4-8 inclusive for spiral and bellows type elements). Turning of this screw moves the span adjusting slider up or down; a downward movement increases the pen reading and an upward movement decreases the pen reading.

(6) The shut-off valve is again closed

and pressure on the system vented to atmosphere by opening of Valve 2.

(7) The zero position is again checked. If necessary, the pen is reset and the foregoing procedure repeated until the instrument calibration is within the tolerance required.

Displacement or "Dead Weight" Tester. This method is the most accurate method for calibration of a pressure gage, because it is not dependent upon a previously calibrated test gage. The method is limited, however, by the fact that a dead weight tester is not usually available for spans less than 25 psi; it is usually employed therefore for spiral or similar Bourdon type elements.

The procedure is as follows:

(1) The gage is disconnected from the pressure line.

(2) The tester is connected to the instrument.

(3) The gage zero position is checked and adjusted, if necessary, as outlined under "Zero Adjustment."

(4) The instrument calibration is checked by addition of weights to the tester platform in increments equal to 10 per cent of the instrument range throughout the entire span. If the instrument is not within the required tolerances, its calibration is reset as covered above under "Single Point and Zero Check."

Standard Test Gage and Regulated Air Supply. This method is very convenient for checking the calibration over the entire instrument range. If a liquid column is used instead of a test gage, low ranges can be checked very accurately.

The procedure is as follows:

(1) The instrument is disconnected from the process pressure line and connected to a regulated air supply as shown in Fig. 10b.

(2) The test gage or liquid column is connected in parallel with the instrument as illustrated. A vent is provided to bleed pressure from the system (such as Valve 2 slightly opened.)

(3) The instrument pen or pointer zero position is checked and required adjustments are made, as outlined under "Zero Adjustment."

(4) The instrument calibration is checked by increase of air pressure in increments equal to 10 per cent of the gage range. It is reset, if required, as covered under "Single Point and Zero Check" above.

Absolute Pressure Gage. Essentially the same recommendations for installation given above apply to the absolute pressure gage. In the measurement of gas or vapor pressure such as common with this gage, particular emphasis is placed on the need for drainage from the low point in the pressure line if the gage is located below the pressure tap and there is a possibility of condensate plugging the connecting line or draining back into the bellows element. In such cases, a condensate trap can be located at the low point and drained at intervals.

Ordinary gage pressure or vacuum test gages may be used for calibration checks on an absolute pressure gage in the field, provided a barometric correction is made for the test gage reading. In order to make a more accurate check, however, the instrument must be connected to a vacuum pump and a mercury column, as shown in Fig. 11, which must normally be set up in the instrument shop. Procedure for this operation is as follows:

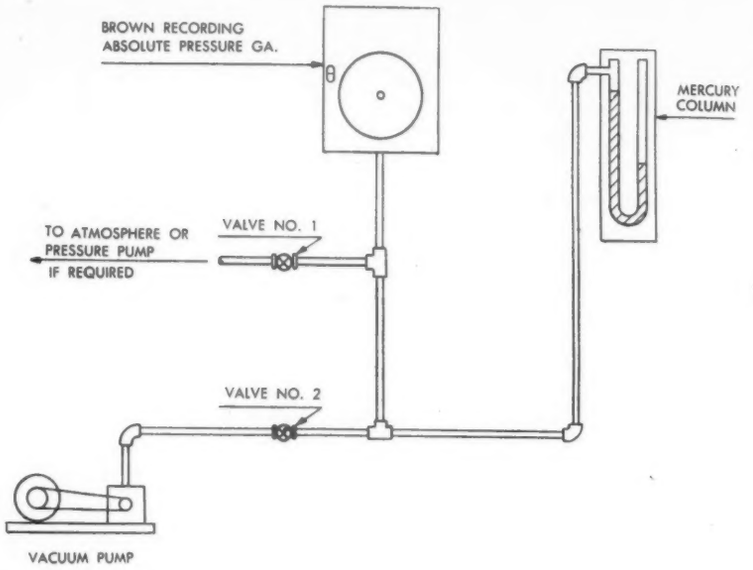

FIG. 11. Method for absolute pressure gage calibration.

(1) Valve 1 is closed and Valve 2 is opened. Vacuum pump is then run for at least 15 min until the vacuum indicated on the mercury column steadies out.

(2) Valve 2 is closed and if the vacuum remains steady (indicating no leaks in the system) record its value as the absolute zero at that particular time. The pen or pointer of the instrument under test should read zero at this point.

(3) The zero adjusting screw on the pen or pointer (see Fig. 8) is set to its mid-position; then the zero position of the pen or pointer is adjusted by turning of the second zero adjusting screw on the bellows arm. (On the non-control instruments and for very small adjustments the pen or pointer zero adjusting screw may be used.)

(4) The range of the instrument is converted into head units in which the mercury column is calibrated and the cardinal point values desired for calibration checks are determined using the value just obtained as the zero reference point.

(5) Valve 1 is then checked until the absolute pressures rises (vacuum lowers) to the first cardinal point is readied on the mercury column. Valve 1 is then closed and the pen or pointer reading is recorded. This procedure is repeated for the remaining cardinal points of the gage range.

(6) If the calibration is not within the proper limits (usually within ± 1

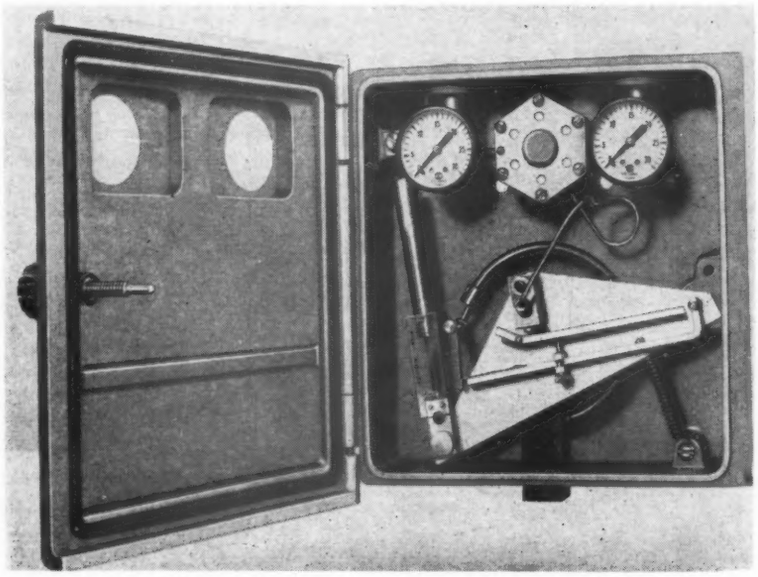

FIG. 12. Non-indicating pressure controller with Bourdon tube element.

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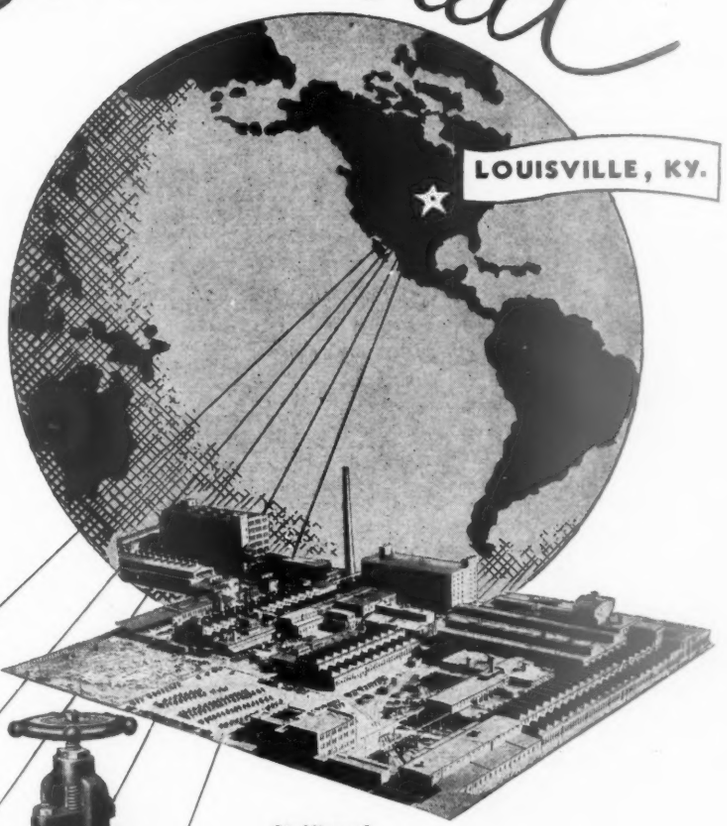

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per cent), the span adjusting screw (see Fig. 8) is turned to move the span adjusting slider on the bellows arm until the pen assumes its correct position on the chart or scale. Downward motion of the slider increases the pen reading; upward motion decreases the reading.

(7) The zero position is rechecked. If necessary, the pen zero is reset and the foregoing procedure is repeated until the instrument is calibrated within the required tolerances.

Bourdon Tube Adjustments. Bourdon tube gages, tested by one of the several methods described above, require only two adjustments, namely: For *multiplication* (span) and *angularity* (zero). From checks of the calibration at various points over the gage range it can be determined whether the pointer must be adjusted to move faster or slower or whether an angularity adjustment must be made.

To adjust for multiplication, the movement or sector sliding arm is adjusted to make the pointer move faster or slower. Angularity adjustment is made by changing the relation of the sector to the pinion gear. This is done by lengthening or shortening the connecting link or by rotating the movement. The section lever arm should be at right angles to the link between the tube tip and the section lever arm.

The extent to which such adjustments are made in the field depends upon the ease of making a replacement. Usually it is more economical to replace the gage than to do extensive adjusting in the field. Adjusting and repair can be done to better advantage in the shop.

In addition to their use in dial-type indicators and recording or indicating instruments, Bourdons are employed in simple non-indicating types of pressure controllers such as illustrated in Fig. 12. This unit employs a pilot relay for pneumatic control and can even be mounted directly on the diaphragm motor valve it is positioning.

Miscellaneous Maintenance Hints. (1) Checking interval should be not more than three months,[6] oftener in accordance with the critical nature of the gage application and the required tolerances of the measurement.

(2) Vibration of machinery is harmful to the gage mounted on it; best answer is not to mount gage in such machinery. If vibration is unavoidable, the gage piping should be braced.

(3) Pressure connections out the side of pipe for liquids and out the top of the pipe for gases are usually recommended. If the gas or vapor gage is to be sealed because of considerable condensate forming in the gage piping, a side connection is recommended.

(4) Where a correction must be made for height of the gage above or below the pressure tap, a test card listing the cardinal check points and the corresponding corrected reading, calculated in advance, facilitates field testing, eliminates the risk of errors in field calculations, and provides a permanent record for file.[6]

(5) Pressure instrument nipples are replaced every two years in one plant to prevent fatigue or corrosion failure.

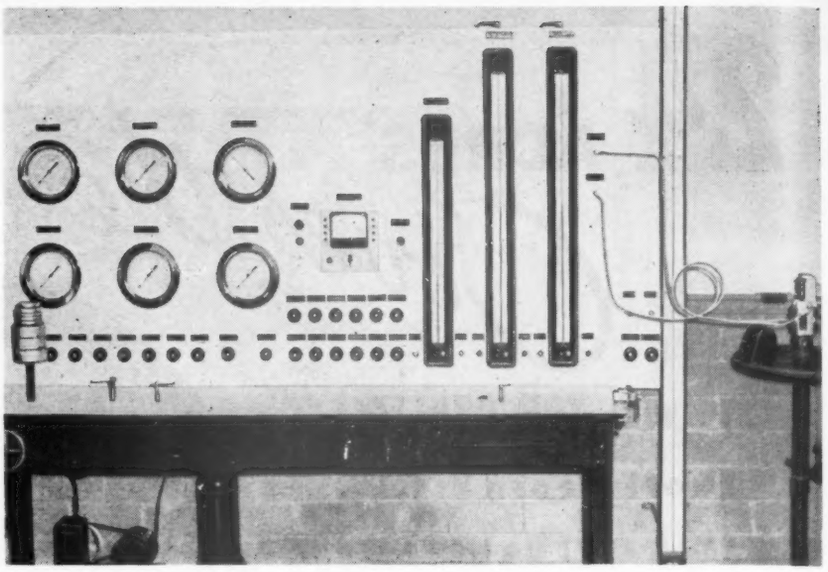

FIG. 13a. View of instrument test panel. Note weights and handwheel of dead-weight tester at extreme left; also vacuum pump at left beneath bench.

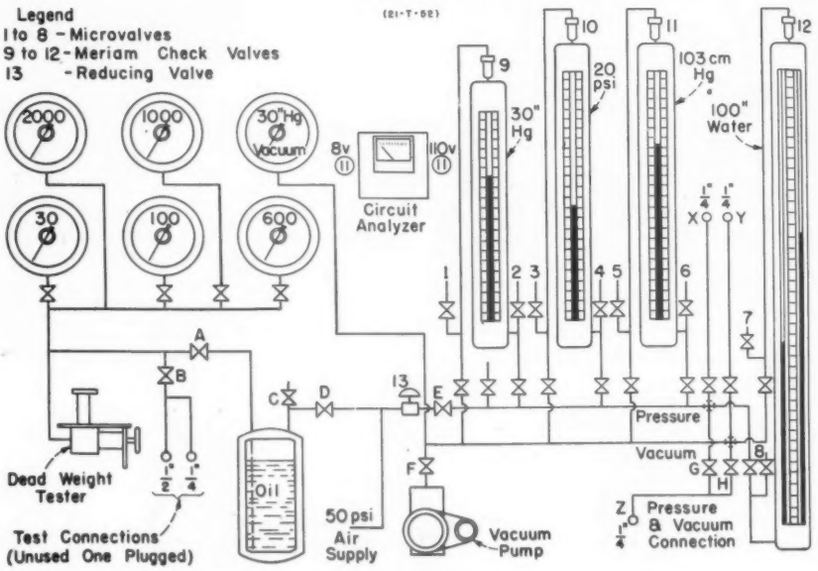

FIG. 13b. Schematic piping layout of test panel with identification of valves and other accessories.

Notes on Testing Equipment. Fig. 13 shows a typical shop test set-up for pressure gages and flow meters.[7] Other articles given under "References" illustrates and describe such testing equipment. A few specific notes are below:

(1) In one refinery laboratory, four test gages are arranged in a testing panel to span the range of 0 to 3000 psi, as follows: 0-200, 0-600, 0-1000, and 0-3000.

(2) The cost of a deadweight tester for pressure above 2000 psi may be prohibitive for some smaller plants, but the use of a simple hydraulic system with one or more standard test gages should be adequate in such cases. A chamber with a screw-fed piston can be made up in the shop to supply the hydraulic test pressure.

(3) Mercury monometers are recommended for low range pressure and vacuum gages, as well as for absolute pressure gages.

(4) Dry air is suitable for pressure checks by this method up to 80 psi in most plants. Nitrogen from cylinders is convenient for higher pressures.

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6. "Field Calibration of Pressure Gages," by G. A. Pettit, ISA Paper No. 52-4-4, a report on work of the members of ISA Sub-Committee of the Maintenance and Operations Committee on "Calibration Techniques," presented at the 1952 ISA Conference in Cleveland.
7. "Instrument Shop Test Panel" by T. L. Clift, *Instrumentation, 4*, 4, pp 29-30 (1950).

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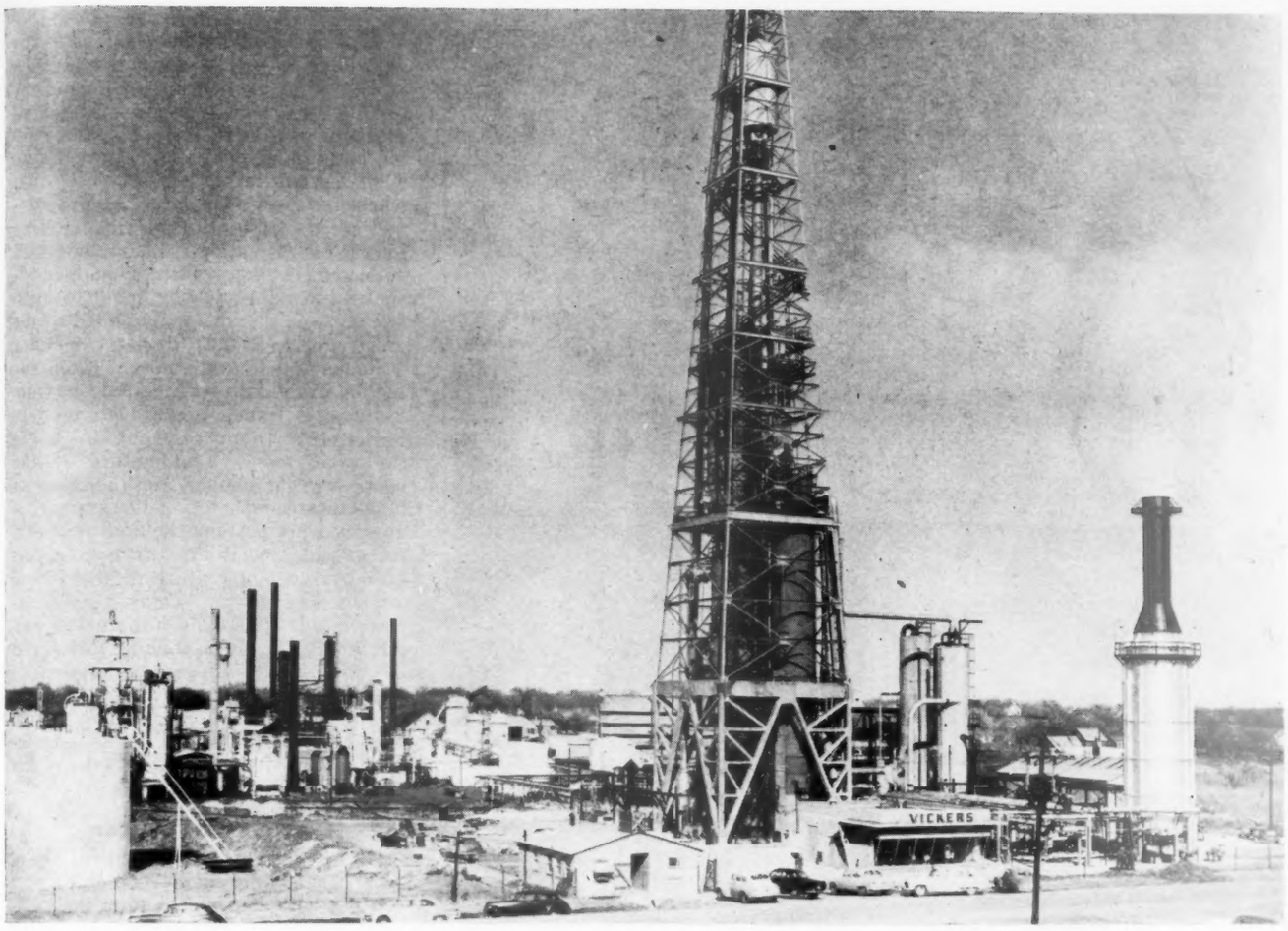


New TCC packaged unit at Vickers' Potwin, Kansas, renfinery. Throughput of this plant is increased to 12,000 bbl per day.

Newest TCC Packaged Unit on Stream

Use of standard units in design, of shop fabrication and of a derrick supporting structure cuts costs to the bone

ARCH L. FOSTER*

THE second Thermofor catalytic cracking packaged unit to be built was placed on stream a few weeks ago by Vickers Petroleum Company at its Potwin, Kansas refinery, according to announcement by Jack A. Vickers, Jr., company president. This is a major step in the modernization of a small refinery and is the main item in its modernization program.

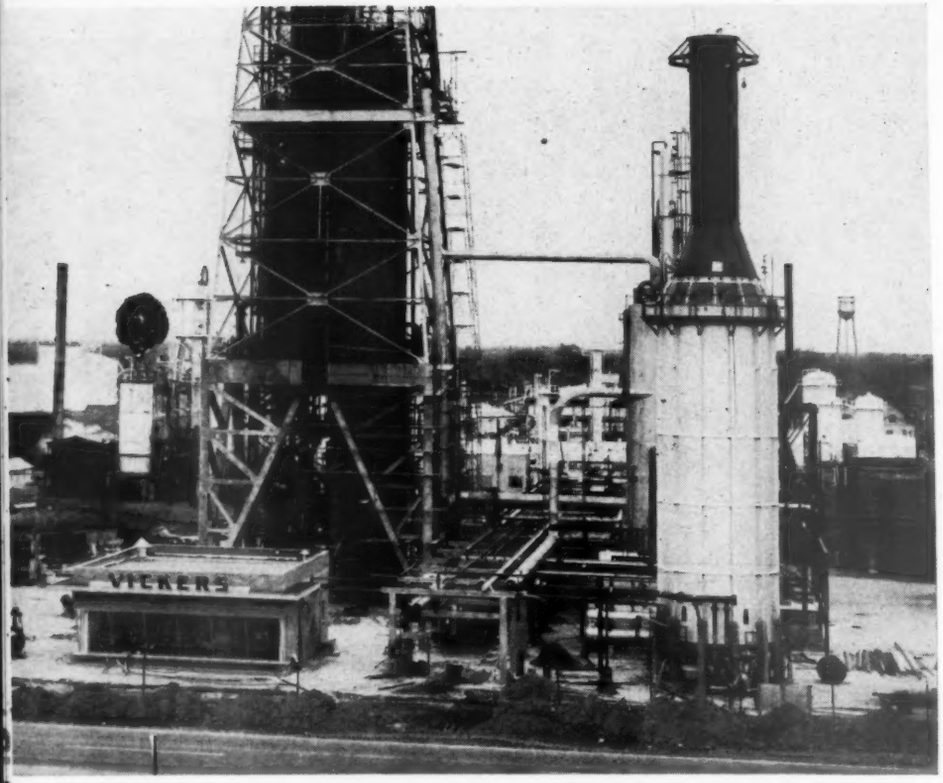
Design of this plant in general is similar to the first packaged plant, operation of which was begun in 1951 at the refinery of New Mexico Asphalt and Refining Company at Artesia (See "First Package-Type TCC Unit Operation Successful," *The Petroleum Engineer*, July, 1952, page C-7). Both plants are designed to give maximum throughput and operating efficiency with minimum cost. In brief, this is accomplished by the use of standard, prefabricated units in making up the design of the plant, equipment that can be bought "as is" and "over the counter" without special fabrication, thus reducing the cost of each important item to the minimum.

For example, the catalytic unit requires a large, tall supporting structure to carry the weight of various pieces such as the reactor, regenerator, exchangers, and other items. The conventional oil derrick is a standard item of shop manufacture, utilized widely throughout the world, in various heights and degrees of strength and thus its cost is reduced importantly. Similiarly, flowsheets are standardized with variations easily possible to fit specific situations. Shop fabrication cuts costs also, as does a standard plot plan subject to some variations to fit individual situations. Much of the plant is pre-engineered to minimum costs.

The unit is divided into four sections, with a fifth as the polymerization sec-

*Editor, Refining and Processing.

EXCLUSIVE



Frontal view of the new Vickers unit, showing the control room, left foreground, cylindrical heaters, right foreground, piping in center and main structure in background.

tion, the latter having been revamped and expanded to handle added gas production. The crude unit at the refinery was doubled in capacity to 12,000 bbl per stream day, while fractionation capacity to produce liquefied petroleum gases was added. The unit is licensed by Socony-Vacuum Oil Company and was built by Southwestern Engineering Company of Los Angeles. T. Ben Arnold directed the construction with Del Kelley as superintendent.

The plant proper includes the feed preparation section with feed heater, flash (atmospheric) and vacuum towers, and the catalytic section with catalyst hopper, reactor, a "double flow" catalyst regenerator, catalyst storage, and fines-removing elutriator equipment. The fractionation section includes the fractionator tower, stripper, and auxiliary equipment. Gas recovery section has an absorber in which is built a top section for deethanizing the rich absorption oil, a "sponge absorber" or reabsorber, stabilizer, and caustic scrubbers. The new polymerization section includes water settler, polymerizer column containing solid phosphoric acid catalyst, a debutanizer for the raw polymer, and a depropanizer tower to split the debutanizer overhead into propane and butane for LPG.

Gas Lift for Catalyst

One major innovation over the design of earlier TCC units is the gas-lift principle for handling regenerated catalyst and returning it to the overhead hopper, to replace the older bucket-and-chain system now in discard.

The feed preparation sections are designed to handle either cold or preheated gas (distillate) oil charge, a topped crude or whole crude, as conditions may dictate. Hot streams from the main fractionator section may be used as preheat vehicles in exchanger systems. Recycle streams from that section may be sent to thermal cracking units for further cracking to increase overall gasoline yield, as the operator chooses. A vacuum unit may be employed to prepare heavy overhead gas oil charge stock, eliminating the unvaporizable asphaltic bottoms that add greatly to the burning load on the regenerator without adding appreciably to the overall cracked product yield. The combination of atmospheric and vacuum flashing operation for feed preparation is carried out normally by utilizing a temperature on the charge to the atmospheric column such that after flashing off the light and intermediate fractions, the heavier bottoms to the vacuum unit require little if any additional heat to vaporize the required fraction under a vacuum of 25 in. of mercury or higher. The heavy gas oil is charged to the reactor as liquid. Light gas oil stock may enter in vapor form, thus constituting the liquid-vapor charge to the reactor. The Vickers unit handles 4000 bbl per stream day of fresh gas oil feed in two phases, and is designed to handle also 2500 bbl of recycle oil per day, the unit operating at about 75 per cent total conversion. To follow the cycle hot catalyst from the overhead hopper flows via gravity into the top of the moving-bed reactor, the catalyst at about 950 F, and the charge mixes continuously with the catalyst stream, vapor, and liquid as well. Catalyst passes slowly downward through the reactor, is freed of any entrained oil at the bottom in a special section, and then flows, still by gravity, into the top of one of the two kiln sections. Vapors of cracked and uncracked charge are removed in the special section near the reactor bottom—a section just above that where the spent catalyst is withdrawn—and are transferred to the fractionating tower. Excess catalyst, if any excess is collected in the overhead hopper, is shunted in a downflowing line to catalyst storage, and may be again added to the catalyst cycle in the "lift pot."

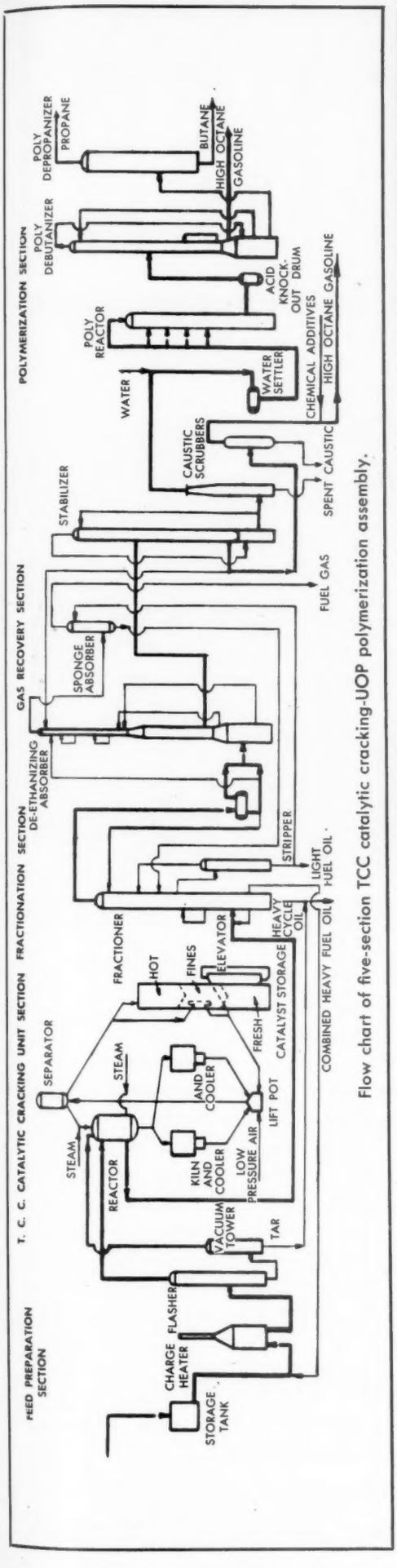
Regenerated catalyst drops from the bottom of the kiln into this lift pot from which it is transported via air up into the storage hopper again to begin the cycle anew. Temperature of the catalyst in the hopper, and therefore its temperature on entering the reactor, is governed not only by the final temperature maintained in the kiln bottom, but also by the temperature of the lifting air entering the pot. Catalyst temperature may be raised by introducing hotter lift air, or correspondingly lowered by using cooler lift air. A portion of the catalyst is bypassed continuously through the elutriator system by which fines are removed and discarded, as accumulation of fines interferes with the efficiency of the system.

Two Carbon Burners

Each of the two kilns, identical in design, can handle about 1650 lb of carbon per hour, burning it from the catalyst. Two smaller burners were used instead of one larger one, since the smaller size meant shop fabrication with resultant lower costs as against field fabrication and greater cost. This plan also allows greater flexibility in operating the carbon burning section and therefore of the whole unit.

Regeneration temperatures are held below 1250 F, as much higher temperatures affect adversely the activity (efficiency) of the recycled catalyst. The regenerated catalyst leaves the kiln bottom at 1250 F and becomes a boiler heating medium, passing the exchanger (shell-and-tube) units in which heat is exchanged with water to produce steam while cooling the catalyst to about 1000 F, approximate temperature that will send the catalyst back into the reactor at 950 F, desired operating (cracking) temperature. Final catalyst move is by means of low pressure ($3\frac{1}{2}$ psig) air that lifts it up the elevator shaft to the hopper on top.

A number of features of the design, construction, and operation of this unit are of interest to refiner engineers. The oil-well derrick type of supporting structure, built itself from standard plans and specifications, is erected in complete and final form on the unit site before construction of the unit proper is continued. This derrick serves as permanent scaffolding and rigging not only to be used in hoisting equipment into place and supporting it afterward, but serves also as permanent rig in repairing or replacing any items in the unit. This saves installation cost and time, and the erection and eventual removal of special



Flow chart of five-section TCC catalytic cracking-UOP polymerization assembly.

General layout of Vickers unit, heat exchangers and main fractionators, etc.

derricks and rigs that do not become a fixed part of the unit but must be dismantled and carried away when construction is completed.

Flexibility and economy of operation in all phases, maintenance as well as on-stream operation, are the key ideas employed throughout the design of the unit. In addition to the derrick-rig advantages, engineers point out that exchangers are so located and arranged that they can be removed easily from their location. Superstructures are arranged permanently to facilitate removal of tube bundles or whole exchangers in minimum time, using hoists and trolleys. Overhead trolleys are installed also in the compressor house, to facilitate the replacement, dismantling and general servicing of the compressors.

The control room houses a "semigraphic" panel and has included a system of alarms that call to the operator's attention any upset in or malfunctioning of the unit or its process routines. To avoid serious mishaps, the instrumentation installed is such that in case of power failure, for example, the entire unit will be bypassed instantly and shut down. Not only is the flow routine shown on the panel, with the instruments installed there, and the points of control indicated, but by a color code system the different process lines are identified.

Dependable data regarding the catalyst loss percentage in this unit are not yet available and it will be some time before running experience is sufficiently exhaustive to warrant reports based on actual figures obtained from operations. Other data however, (see reference), show that for a six months' period the losses, operating with Socony bead catalyst, averaged about 0.4 lb per barrel of charge. For the second three months of this period the attrition loss averaged only 0.3 lb per barrel of charge. For typical operations on other plants maintenance of a catalyst activity level of 32, determined by a standard procedure, gives entirely satisfactory operation results.

At dedication ceremonies a plaque was presented by Jack A. Vickers, Jr., president of Vickers Petroleum, to Robert P. Miller, Southwestern Engineering (Sweco) Company in recognition of the unit's having been built with fewer man-hours than was estimated and also for its construction at less than the estimated cost. * * *

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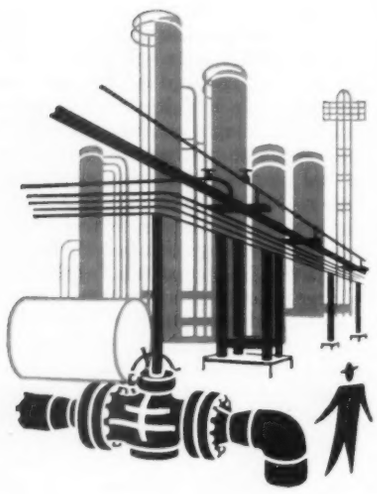

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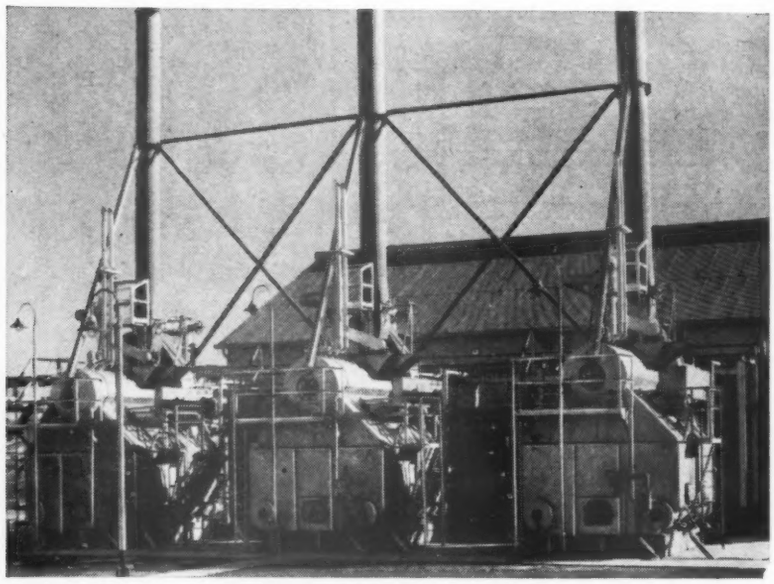

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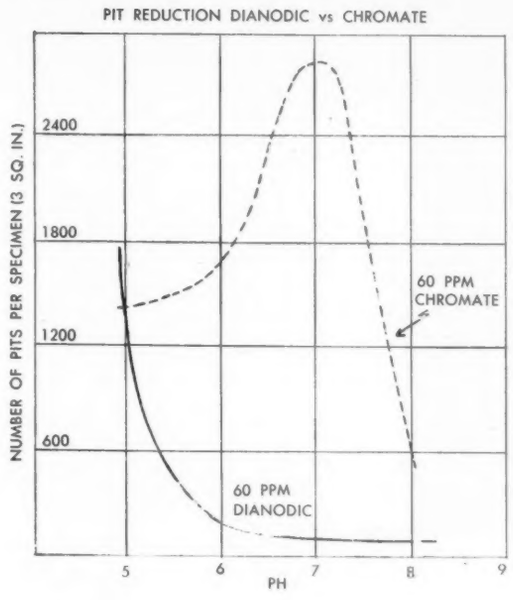


FIG. 1. Reduction in pitting effected by Dianodic method.

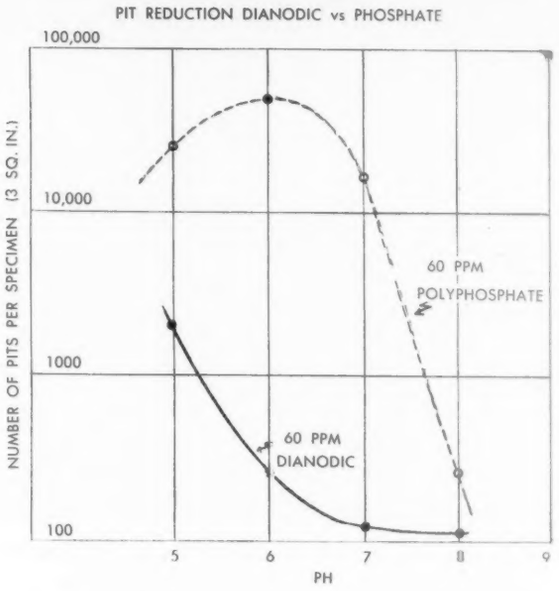


FIG. 2. Comparison of pitting control effected by Dianodic and by Polyphosphate treating methods.

Corrosion Control in Cooling Water Systems

Many factors interfere in the water treatment; combination methods have solved many problems

W. A. TANZOLA*

PRIMARY cause for corrosion in recirculating cooling water systems is dissolved oxygen. In the past, treatment of cooling water systems for prevention of corrosion has been attempted through the controlled deposition of calcium carbonate coatings over the metal surfaces. This practice was never very successful due to the difficulty of establishing a uniform, impervious coating over the metal surfaces without seriously impeding heat transfer.

Controlled scale formation as a means of corrosion prevention lost favor to the anodic inhibitors, such as the chromates, nitrites, and polyphosphates. These materials increase anodic polarization, probably by helping to form or by keeping in repair a protective film on the metal surfaces that renders the metal, in effect, more noble. Anodic inhibitors can provide excellent protection providing the concentration is sufficiently high to completely stifle corrosive attack. When the concentration level is insufficient to completely control attack, pitting and tuberculation result. In plant practice, anodic inhibitors frequently have been employed at concentrations lower than those required to completely stifle corrosive attack. Reasons for such insufficient treatment include the desire to minimize treatment cost and also, when polyphosphates are used, to avoid the deposition of calcium phosphate.

With the use of chromates at insufficient concentrations, attack manifests itself by the formation of nodules, under which pitting is present. The attack with polyphosphates alone, usually leaves the metal surfaces free of nodules or tuberculation, but pitting is very much in evidence.

It should be emphasized that pitting attack may occur for reasons other than the use of an insufficient concentration of inhibitor. Anodic areas of attack may develop under loose scale, under deposits of foreign matter, in crevices, at points of stress or from contact with dissimilar metals.

*W. H. and L. D. Betz, Inc.

Dianodic Method

Polyphosphates and chromates are anodic inhibitors and it is contrary to expectations to find that a combination of these two anodic inhibitors at relatively low cencentrations and under controlled conditions of pH will reduce pitting to a minor fraction of the pitting produced with each material used separately. This method of treatment has been termed the Dianodic method because of the combination of two anodic inhibitors. A comparison of the effectiveness of this method with its components used separately will be of interest.

Fig. 1 shows the reduction in pitting by the Dianodic method compared to straight chromate when each material is used at a concentration level of 60

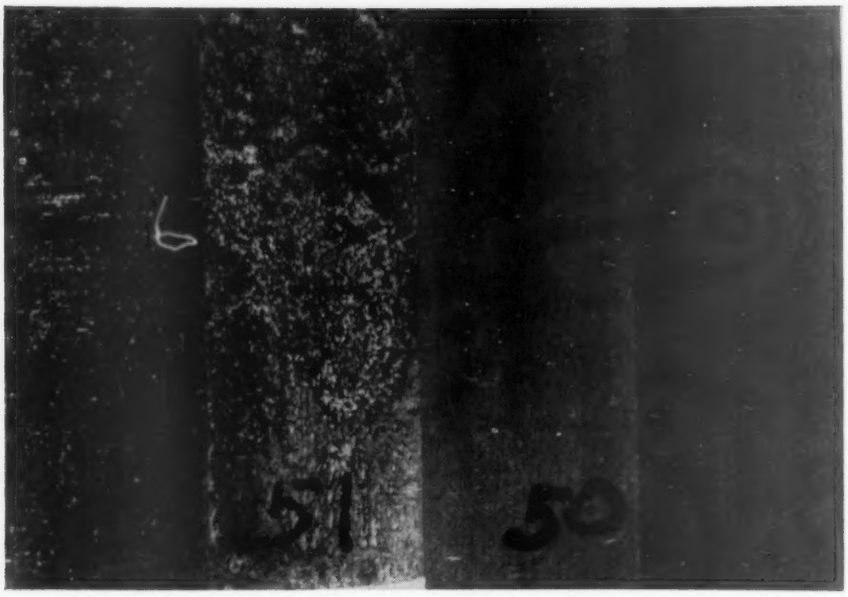


FIG. 3. Test specimens showing comparative corrosion results.

ppm. Reduction in pitting secured with the Dianodic method compared to polyphosphate is illustrated in Fig. 2. These results were secured using a Dianodic treatment consisting of 40 ppm of polyphosphate and 20 ppm of sodium chromate. A marked reduction in pitting is secured with various ratios of polyphosphate to sodium chromate and therefore a great degree of flexibility is available to avoid calcium phosphate deposition.

Fig. 3 shows a photographic comparison of the specimen surfaces exposed under each of these methods of treatment. The marked reduction of pitting by the Dianodic method is readily apparent. It should be further noted that the characteristics of the active area have been altered. Examination of this area under the microscope will show that the Dianodic treatment changes the attack from a pit to a slight anodic surface etch of no measurable depth.

Results were secured under pilot plant conditions in the research laboratory. During the past three years, this method has received widespread acceptance under a variety of field operating conditions and in plants of many different types. Results of this treatment method have been followed in most of the applications by the exposure of test specimens in the system. Test specimens employed were usually of mild steel with approximately three square inches of surface area. Test specimens were exposed in the cooling water system by means of a by-pass arrangement that permitted cooling water to flow past four specimens in series. One such arrangement was usually installed to take water from the discharge side of the circulating pumps and return it to the tower sump while another was installed to take water from the hottest heat exchanger or, where this installation was not convenient, from the hot return line to the tower. One specimen from each location was removed at regular intervals and cleaned cathodically. Average penetration values were calculated from the weight loss data while the maximum penetration values were measured with a calibrated microscope.

Table 1 shows a comparison of the average and maximum penetration values under plant conditions of three types of treatment. The low range polyphosphate treatment level was 2-4 parts per million (ppm) as polyphosphate with a total phosphate of 4-8 ppm. The conventional chromate treatment was in the range of 200 ppm expressed as sodium chromate. The Dianodic treatment level was 60 ppm. It will be noted that maximum penetration values for the phosphate system averaged 0.66 in. per year. The chromate system reduced the severity of pitting to 0.15 in. per year. This value, however, still represents excessive concentrated attack. The Dianodic method reduced maximum pit depth to less than 0.02 in. per year. This value represents a reduction of at least 87 per cent over conventional chromate treatment and at least 95 per cent over low phosphate treatment.

Table 2 shows the results secured at a large refinery and serves to illustrate the stifling of the pitting function by the Dianodic treatment with time. Data in this table were secured by exposure of a set of four test specimens, three of which were exposed for approximately monthly intervals while the fourth specimen was exposed for the entire 116 day period. The losses for each interval were in close agreement. It will be noted further that of the corrosion that takes place during the entire 116 days, the major portion of it occurs during the first 39 days. The difference 224 minus 140 milligrams or 84 milligrams were lost during the last 77 days. The average penetration for the last 77 days was only 0.001 in. per year showing that the corrosion is being stifled with time. The maximum penetration values also show that the pitting function did not increase after the first 39 days and pitting has been arrested.

Results of plant tests at different temperatures in the same system are shown by Table 3. Losses at the higher temperature are greater as would be expected. It should be noted, however, that with time the attack is decreasing showing that attack is being stifled.

Corrosion of Non-Ferrous Metals

As admiralty metal tubes find wide application in heat exchangers, data on the losses suffered by this metal are of interest. The exposure of admiralty specimens has shown that the losses are negligible, on the order of 0.0002 in. per year. The losses with conventional chromate treatment are of the same order. With high phosphate treatment alone, however, losses are higher on the order of 0.0020 in. per year. While this rate is not excessive it does represent a considerably higher rate compared to the other methods of treatment.

TABLE 1. Plant comparison of three treatments on basis of average and maximum penetration.

Low phosphate[1] treatment	Conventional chromate[2] treatment	Dianodic[3] treatment
Maximum penetration, inches/year		
0.83	0.065	*
0.57	0.13	0.03
0.59	0.16	*
	0.19	0.02
Avr. 0.66	Avr. 0.15	Avr. 0.02
Average penetration, inches/year		
0.003	0.0008	0.0022
0.031	0.0018	0.0026
0.027	0.0058	0.0012
0.023	0.0048	0.0018
Avr. 0.021	Avr. 0.0033	Avr. 0.0020

* Too small to measure.
[1] Circulating water pH 6.7, sulfate 384 ppm, chloride 548 ppm
[2] Circulating water pH 7.5, sulfate 55 ppm, chloride 142 ppm
[3] Circulating water pH 6.2, sulfate 448 ppm, chloride 34 ppm

TABLE 2. Plant tests showing reduction of average and maximum penetration with time.

Dates exposed	Days	Loss, mgs	Average P (in./yr.)	Max P (in./yr.)
3-20 to 4-28.....	39	140	0.0034	0.032
5-1 to 6-2.....	32	130	0.0039	0.036
6-9 to 7-14.....	35	118	0.0032	0.028
3-20 to 7-14.....	116	224	0.0018	0.012

(Recirculating water analysis: Ca as $CaCO_3$ 90 ppm, Mg as $CaCO_3$, 30 ppm, Methyl orange alkalinity 25 ppm as $CaCO_3$, 320 ppm Sulfate as SO_4, 120 ppm Chloride as Cl, pH 6.0 to 6.5)

TABLE 3. Simultaneous plant tests at different temperatures in the same system.

Pump discharge (80—90 F)		
Days exposed	Loss, mgs	Penetration-ipy
28	66	0.0022
42	64	0.0014
56	78	0.0013
Return line (110—120 F)		
Days exposed	Loss, mgs	Penetration-ipy
28	92	0.0031
42	143	0.0032
56	163	0.0028

(Recirculating water analysis: Calcium as $CaCO_3$ 256 ppm, Magnesium as $CaCO_3$, 144 ppm, methyl orange alkalinity as $CaCO_3$ 16 ppm, Sulfate as SO_4 1400 ppm, Chloride as Cl 1700 ppm, pH 5.9 to 6.3)

Use of steel tube sheets with admiralty tubes is common practice and of interest are the losses with this bimetallic system. Table 4 shows the weight losses of steel specimens coupled to admiralty specimens, steel specimen alone, and admiralty specimen alone all properly insulated and exposed simultaneously in the same cooling box.

The losses for steel and admiralty, uncoupled, were negligible. The coupled specimens showed a marked increase in attack on the steel specimen. Although the average penetration is in a satisfactory range most of the attack was concentrated. This type attack can be reduced by increasing the treatment concentration over the 60 ppm level employed in this system. Only about 15 per cent of the heat exchange material in this system contains this type of equipment. As can be seen, the uncoupled steel specimen losses were negligible and it was not considered economically justified to increase treatment any further to protect a minor portion of the system. Instead, it has been proposed that the point of addition of treatment be changed from the pond to the cooling box. At this plant, daily treatment requirements are 125 lb. The flow through the cooling box is approximately 100 gal per minute equivalent to 1,200,000 lb per day. The addition of treatment to the cooling box would bring about an increase in treatment concentration of more than 100 ppm. Through this expedient, without increasing the quantity of treatment used per day, treatment concentration will be increased at this critical point and additional protection will be obtained.

Occasionally, aluminum tube bundles are encountered in cooling tower systems. A limited amount of data has been collected by exposing aluminum specimens in Dianodic treated systems. These data show the losses to be on the order of one milligram per day per three square inches. The average penetration in terms of inches per year is only 0.0030. Here again, it has been found that polyphosphate treatments alone produce higher losses on this metal.

Effect of Deposits

The application of the Dianodic method of treatment in the field to systems that have already suffered serious corrosion has served to demonstrate the marked corrosion load imparted by deposits, corrosion products, and foreign matter. Almost invariably, old corrosion products will slough off during the initial application of treatment. The corrosion products will migrate to other sections of the system and some will settle at points of slow circulation. The new areas exposed at points of sloughing off will become anodic to the adjacent corroded areas. At the same time, when the migratory corrosion products settle on uncorroded surfaces, such as the test specimens, cell action takes place and serious corrosion results. The corrosion load during the sloughing off period is quite high and temporarily imparts an added corrosion load that must be dealt with during the sloughing off period. The field data that have been collected very definitely demonstrates the marked corrosion load imparted by such deposits.

Table 5 shows data collected at one plant at which Dianodic treatment had been applied to a system that had undergone very serious corrosion. It will be noted that the corrosion rates at both the hot and cold test rack were quite high and the losses in the hot were higher, as would be expected. It should further be noted that the losses were not consistent. For example, both 90 day specimens show lower losses than the 60 day specimens. This condition was due to the incidence of migratory corrosion products accumulating on the specimens, setting up cell action and accelerating attack. The corrosion load imparted by this condition was more than could be handled by the 70 ppm treatment level and it was necessary to temporarily increase treatment to 200 ppm to bring the attack under control.

TABLE 4. Weight loss data on steel specimens coupled to admiralty specimens.

Metal	Loss, mgs	Penetration, ipy
Steel.....	22	0.0005
Admiralty.....	13	0.00027
Coupled		
Steel.....	148	0.00334
Admiralty.....	7	0.00015

(All strips were 1 by 3 in. size exposed for 21 days in the cracked oil tower overhead cooling box. Average water temperature, approximately 95 F)

TABLE 5. Effect of deposits on corrosion load and treatment level.

Treatment level=70 ppm (Dianodic)		
Pump discharge		
Days exposed	Loss, mgs	Penetration–ipy
30	576	0.0182
60	1451	0.0230
90	1310	0.0138
112	1459	0.0124
Return line		
Days exposed	Loss, mgs	Penetration–ipy
30	738	0.0232
60	1777	0.0280
90	1488	0.0157
112	2151	0.0182
Treatment level=200 ppm (Dianodic)		
Return line		
Days exposed	Loss, mgs	Penetration–ipy
14	163	0.0110
28	73	0.0025
42	116	0.0026
56	131	0.0022

TABLE 6. Effect of suspended solids on corrosion load.

Pump discharge (Unfiltered)		
Days	Loss, mgs	Penetration–ipy
14	51	0.0035
28	221	0.0075
42	205	0.0046
56	509	0.0086
Return line (Filtered)		
Days	Loss, mgs	Penetration–ipy
14	78	0.0053
28	137	0.0046
42	58	0.0013
56	76	0.0013

(Recirculating water analysis: Calcium as $CaCO_3$, 12 ppm, Magnesium as $CaCO_3$ 6 ppm, Methyl orange alkalinity as $CaCO_3$ 60 ppm, Sulfate as SO_4 1800 ppm, Chlorides as Cl 1600 ppm, pH range 6.5 to 6.7)

Suspended Matter Corrosive

Table 6 will also serve to illustrate the marked corrosion load imparted by corrosion products and foreign matter. These data were secured by installing a small homemade filter ahead of the test rack in the hot return line. It will be noted that the losses for the cold, unfiltered water are substantially higher than losses for hot filtered water. Normally, the hot specimens would show a much higher loss than the cold specimens. Specimens in the hot were only subjected to the corrosion load imparted by the water characteristics. Specimens in the cold line were subjected to the corrosion load imparted by the water characteristics and the suspended matter. In spite of the fact that the water was saturated with oxygen, and the chlorides as Cl and the sulfates as SO_4 were each on the order of 1500 to 1800 ppm, it will be noted that this corrosion load was minor compared to the corrosion load imparted by the suspended matter.

Side Stream Filters

In many systems the foreign matter may be due to sand or silt carried in with the make-up water. Where this has a marked influence on the corrosion rate and requires high treatment concentrations to stifle attack, filtering of the make-up water will prove economically advisable. In some cases, the foreign matter originates from other sources such as: Dust, lint, or fibers blown into the tower, and filtering of the make-up water will not bring about a solution to the problem. In these cases, the installation of a side stream filter should be given consideration. The size of the side stream filter needed to effect reduction in suspended solids can be determined from the following formula:

$$F = \left(\frac{SSi}{SSf} - 1\right) B.D.$$

Where:

F = filtering rate required, gpm
B.D. = existing blowdown rate, gpm
SSi = initial suspended solids, ppm
SSf = final suspended solids, ppm

For example, if the average suspended solids of the circulating water are 100 ppm with an existing blowdown rate of 50 gpm and it is desired to reduce the suspended solids to 10 ppm, the filtering rate necessary would be:

$$F = \left(\frac{100}{10} - 1\right) 50 = 450 \text{ gpm}$$

Cost of the unit or units may be economically justified where excessive quantities of treatment are required to stifle attack due to suspended or foreign matter.

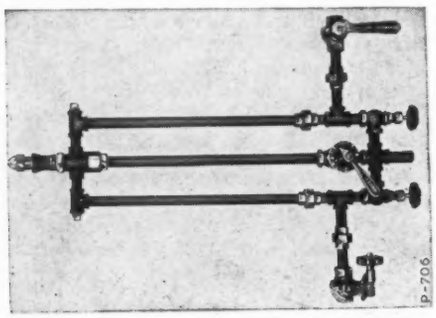
It should also be pointed out that the presence of a heavy accumulation of deposit at isolated points in the system will prevent the treatment from reaching the metal surfaces and attack will continue under the deposits. This condition was demonstrated at one plant using an undersized heat exchanger. Excessive

TABLE 7. pH values maintained in plant operation.

Plant	Location	Circulation rate, gpm	Type heat exchange equipment*	pH Prior to dianodic	pH With Dianodic
1	California	3,400	1, 2, 3	7.5 — 8.0	5.8 — 6.3
2	California	20,000	2, 3	7.2 — 7.8	6.0 — 6.6
3	Ohio	10,000	2, 3	7.5 — 8.0	6.2 — 6.5
4	Kansas	3,500	3	7.0 — 7.3	6.5 — 7.0
5	Ohio	40,000	2	7.5 — 7.8	6.0 — 6.3
6	Texas	8,400	2	6.5 — 7.5	6.0 — 6.3
7	Texas	2,500	1, 2	7.9 — 8.5	6.1 — 6.7
8	Texas	17,000	1, 2	6.7 — 7.2	6.3 — 6.7
9	Texas	1,200	2	8.1 — 8.5	6.5 — 6.9
10	Kansas	15,000	2	7.3 — 7.8	6.0 — 6.3
11	Arizona	1,350	1	8.0 — 8.5	6.2 — 6.5
12	Texas	6,500	2	8.8 — 9.3	6.1 — 6.5
13	Texas	15,000	2	7.9 — 8.3	6.1 — 6.5
14	California	10,000	2	7.3 — 7.7	5.8 — 6.3

*1 Atmospheric sections,
2 Shell and tube exchangers,
3 Open condenser boxes.

temperatures developed and scale accumulated on the tubes. The tubes were rodded by simply removing the front head and the unit was flushed and returned to service. In time the separating baffle in the floating head, which had never been removed, pitted through. The flushing operation was not sufficient to permit removal of deposits from the floating head and cell action continued under the deposits. Heat exchangers of certain designs will permit the accumulation of deposits at isolated points and cleaning of the units at these points should be scheduled to avoid the accumulation of deposits to excessive depths. Otherwise, it will be difficult for any treatment to pentrate the deposit and corrosive attack will continue.



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pH Control

Control of pH value is a necessary and integral part of the Dianodic method of treatment. The original introduction of this method met with some resistance due to the low pH values that are necessary. However, because of the excellent results secured with this method of treatment these objections have faded and operation at lower pH values is now commonplace. Table 7 illustrates the changes made at some of the plants that have adopted the Dianodic method of treatment.

These lower pH values preclude the possibility of calcium carbonate scale formation as the pH values are below the saturation index with respect to calcium carbonate for normal waters. Where poor control of pH is encountered some deposition of calcium phosphate can result by exceeding the pH of saturation of calcium phosphate. Deposit formation has not been a serious factor with the Dianodic treatment but is more commonplace when using polyphosphates or polyphosphates with synergists. With these latter materials, it is usually necessary to maintain a higher phosphate treatment level compared to the Dianodic method to cope with the corrosion load and as a result control of pH is more exacting.

It is also pertinent to note that at these lower pH values delignification of cooling tower wood is also avoided. It has been reported that the pH of wood is approximately 6.5 and this corresponds closely to the usual pH range for the Dianodic treatment.

Where chlorination is used for control of slime and algae, the pH range required for Dianodic treatment is also of benefit. Chlorine hydrolyzes in dilute water solution as follows:

$$Cl_2 + H_2O = HOCl + HCl$$

chlorine + water = hypochlorous acid + hydrochloric acid

It is the hypochlorous acid produced in this hydrolysis that provides the disinfecting and oxidizing properties of chlorine solutions.

$$HOCl \leftrightarrows H^+ + OCl^-$$

hypochlorous acid ⇆ hydrogen ion + hypochlorite ion

The relative amounts of undissociated hypochlorous acid and hypochlorite ion are dependent on the pH value of the solution. At lower pH values, such as below 6.5, the equilibrium is such that hypochlorous acid constitutes almost 100 per cent of the available free chlorine.

Summary

Through the medium of these comprehensive corrosion studies, under actual plant conditions, it has been possible to confirm the results previously secured under research conditions in the laboratory. These studies have shown in a practical way the influence of the many factors that enter the corrosion problem. They have aided immensely in demonstrating the effectiveness of this method of treatment and have been instrumental in arriving at the economical solution to many corrosion problems.

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★ ★ ★

Shell Chemical Expands Epichlorohydrin Production

An ample supply of epichlorohydrin for both the present and future needs of the nation is assured by a new epichlorohydrin plant Shell Chemical Corporation has just brought on stream in Houston, Texas, according to an announcement by Jan Oostermeyer, president of the company.

Epichlorohydrin has recently become a key chemical product. Not only is it a major component of epoxy resins, but it is also used in adhesives and chemical intermediates, and as a stabilizer in insecticides.

"Epichlorohydrin had been so little used before the war that many people thought we had overbuilt when we constructed our first plant in 1947," Oostermeyer said. "But the expansion of the market has necessitated this current threefold increase in our production facilities. Naturally, we learned a lot about making epichlorohydrin in these six years and the new plant incorporates several outstanding processing improvements."

The raw material for epichlorohydrin is allyl chloride of which Shell Chemical is the major producer. The allyl cloride is made from propylene obtained from oil refiinery operations and plays a major role in Shell's over-all glycerine production at Houston.

Your questions on refining and gas processing problems answered here. Send yours today!

TECHNICAL FORUM

Fractionator Vapor Load

Q How can the allowable vapor load for a perforated-plate in a fractionating column be calculated? References to recent literature on this subject will be appreciated.

A Actually, there is a range of vapor velocity that will produce satisfactory operation in a perforated-plate fractionating column. The limiting vapor velocities depend upon the design of the individual tower and tray, the quanity of liquid flowing, and the physical properties of the liquid and vapor in contact within the column. Although it is difficult to establish the optimum vapor velocity for a given tower, it is possible to estimate the upper and lower limits of satisfactory operation.

Minimum vapor velocity is that which will just prevent liquid from leaking through the perforations in the tray. It is, in general, essentially independent of the liquid rate and the perforation diameter, but is dependent upon the depth of liquid on the tray. A vapor velocity that causes a dry-plate pressure drop equal to 1/3 of the "solid liquid" height at the downflow side of the tray is recommended as a safe value for design purposes.

Maximum vapor velocity is that which causes flooding in the tower; flooding occurring when the liquid or froth height in the downcomer equals the spacing between trays plus the height of the downflow weir. A sharp decrease in tray efficiency due to excessive entrainment, coning or blowing action may sometimes impose a lower vapor velocity limit than the flooding velocity, but in general flooding will be the limiting condition. Vapor velocities through the perforations as high as 125 ft per second have been observed without excessive coning at a liquid depth of 2 in. The existence of "coning" will depend upon liquid depth and physical properties as well as upon the vapor velocity.

As the holes in perforated plates behave as orifices, an orifice equation of the form

$$\frac{\triangle P_{DP}}{\rho_V} = \frac{V_o^2}{2\, g_c\, C_o^2}$$

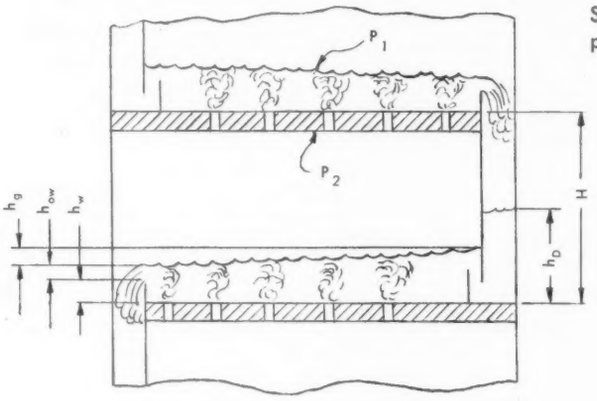
ρ_V = density of the vapor phase, lb/CF

V_o = vapor velocity through the holes, ft/sec

C_o = orifice coefficient

$\triangle P_{DP}$ = pressure drop through the dry plate, psf

can be used to calculate the pressure drop across a dry plate. Conversely, if the pressure drop across the dry plate is known, the corresponding vapor velocity can be calculated from this same equation. The orifice coefficient, C_o, is dependent upon the plate free space, hole diameter, plate thickness, and to a minor degree, the vapor velocity through the holes. Effect of these variables is not yet completely understood, however. Values given in the literature vary from 0.6 for a free space of 4.1 per cent and a 5/16 hole diameter to 0.85 for a 17 per cent free space and a hole diameter of 1/16 in. A value of 0.7 for C_o will probably be a conservative design figure. Free space as used here is the area of the perforations expressed as per cent of the tower cross-sectional area.



Schematic diagram of a perforated plate.

H = Plate spacing, inches

h_D = Liquid height in downcomer, inches

h_w = Height of weir, inches

h_{ow} = Height of liquid over weir, inches

h_g = Hydraulic gradient, inches

h_{avg} = Average static head of liquid on the plate, inches

$$h_{avg} = h_w + h_{ow} + \frac{h_g}{2}$$

Total pressure drop, $\triangle P_T$, between plates can be considered to consist of the sum of the pressure drop across the dry plate, $\triangle P_{DP}$; the average static head of liquid on the tray, $h_{avg.}$; and an additional pressure loss, $\triangle P_B$, which may be the result of bubble formation as the vapor issues from the holes in the plate and to turbulence as the froth mixes and flows across the plate. In summary:

$$\frac{\triangle P_T}{\rho L} = \frac{\triangle P_{DP}}{\rho L} + \frac{h_{avg.}}{12} + \frac{\triangle P_B}{\rho L}$$

Values for $\triangle P_B$ as high as 10 per cent of the dry plate pressure loss have been reported.

If the density of the vapor phase compared with the liquid phase is negligible, the total pressure drop across the perforated-plate may also be written

$$\frac{\triangle P_T}{\rho L} = \frac{h_D - (h_{ow} + h_w + h_g)}{12} + \frac{\triangle P_D}{\rho L}$$

where $\triangle P_D$ is the friction loss in liquid flow out of the downcomer, psf, and h is measured in inches.

From the design details of a given perforated-plate tower, an average liquid seal can be determined. The depth of liquid at the exit weir, $h_{ow} + h_w$, is a good approximation in most cases. Liquid gradient was reported to be negligible in a 6.5 ft diameter tower. If a total pressure drop per tray is now fixed, Equation 2 can be used to determine the dry tray pressure drop and from this value the vapor velocity can be calculated. The above method presupposes a knowledge of the total pressure drop per tray and since these values have been established at the leak point and the flooding point, the limits of the range of allowable vapor loading can be determined. The optimum vapor velocity can only be said to lie someplace between these limits. It is general practice, however, to operate with the downcomers somewhat less than half filled.

Very little data have appeared in the literature on the subject of perforated-plate fractionating towers and therefore, as far as possible, conservative "rules of thumb" that should give workable designs have been suggested.

Example Problem

Calculate the vapor loadings for a perforated-plate fractionating tower at the leak point and also when operating with the downcomers half filled.

Data:	Tower diameter	4 ft
	Plate spacing	18 in.
	Plate free space	15 per cent
	Hole diameter	¼ in.
	Weir height	2 in.
	Vapor density	0.1 lb/cu ft
	Liquid density	50 lb/cu ft
	Liquid rate	100 gpm
	Weir length (chord type)	3 ft

a. Vapor loading at the leak point.

1. Determine h_{ow} by a weir formula. (See reference 3)

h_{ow} = 1.05 in. of liquid flowing

2. Determine $h_{ow} + h_w$.

$h_{ow} + h_w = 1.05 + 2.0 = 3.05$ in. of liquid

3. Determine the pressure drop for the dry tray.

$$\left(\frac{\triangle P_{DP}}{\rho L} = .33\ (h_o + h_{ow})\right)$$

$$\frac{\triangle P_{DP}}{\rho L} = 0.33\ (3.05)$$

$$= 1.02 \text{ in. of liquid}$$

4. Calculate the vapor loading corresponding to this dry tray pressure drop from Equation 1.

$$\frac{\triangle P_{DP}}{\rho v} = 1.02 \times \frac{50}{0.1}$$

$$= 508 \text{ in. of vapor}$$

$$\frac{508}{12} \text{ ft} = \frac{V_o^2}{(2)\ (32.2)\ (0.49)\ \text{ft/sec}^2}$$

V_o = 36.6 ft/sec through the holes

$$\frac{(36.6)\ (15)}{100}$$

= 5.50 ft/sec through the tower

$$\text{tower area} = \frac{(4)^2\pi}{4} = 12.6 \text{ ft}^2$$

Vapor load (5.50) (12.6) = 69.3 cu ft per second.

b. Vapor load when downcomers are half filled with liquid.

1. Determine h_{ow}. (See reference 3)

h_{ow} = 1.05 in. of liquid flowing

2. Estimate h_g.

negligible (See reference 1)

3. Find $(h_{ow} + h_w + h_g)$.

$h_{ow} + h_w + h_g = 1.05 + 2.0 = 3.05$ in. of liquid.

4. Calculate $\frac{P_D}{\rho L}$ (See reference 3)

$$\frac{P_D}{\rho L} = 0.004 \text{ in. of liquid}$$

5. Determine the total pressure drop per plate from Equation 3.

half filled downcomer $\frac{18+2}{2} = 10$ in. of liquid

$$\frac{P_T}{\rho L}$$

$= 10 - 3.05 + 0.004 = 6.95$ in. of liquid

6. Calculate the dry tray pressure drop from Equation 2.

$P_B = 0.1\ P_{DP}$

$$\frac{P_T}{\rho L} = 1.1 \frac{P_{DP}}{\rho L} + h_{avg.}$$

$$\frac{P_{DP}}{\rho L} = 3.54 \text{ in. of liquid}$$

7. Calculate the vapor loading corresponding to this dry tray pressure drop from Equation 1.

$$\frac{P_{DP}}{\rho v} = 3.54 \times \frac{50}{0.1} = 1770 \text{ in. of vapor}$$

$$\frac{1770}{12} \text{ ft} = \frac{V_o^2}{(2)\ (32.2)\ (0.7)^2} \text{ ft}^2/\text{sec}^2$$

V_o = 68.5 ft/ sec through holes

$$\frac{(68.5)\ (15)}{100}$$

= 10.3 ft/sec through tower

Vapor load = (10.3) (12.6) = 130 cu ft/sec.

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Synthetic Lubricants From Ethylene

Q What are the essential reaction steps, catalysts employed, relative proportions of reactants and typical reaction conditions in the synthesis of lubricants and similar heavy oils from ethylene?

A The Germans during the last war prepared high viscosity index lubricating blending stocks by the catalytic polymerization of ethylene. These oils met the following specifications:

Polyethylene oil	A	B
API gravity	31.9	32.3
SSU at 210 F	205 min.	105 max.
Viscosity index, min.	107	115
Pour point, max.	—13 F	—31 F
Flash point, min.	435 F	392 F

Ethylene of 95 per cent purity free from carbon oxides, oxygen, and sulfur compounds was polymerized in batch autoclaves. The permissible diluents were hydrogen, methane, and ethane. The acetylene content in the ethylene was very low having been removed by hydrogenation over a nickel chromium catalyst. The aluminum chloride contained about 5 per cent ferric chloride. The batch cycle is from 12 to 14 hr.

In carrying out the polymerization the sequence of steps is:

1. A slurry of aluminum chloride (about 6 per cent by weight on the finished lubricating oil) is made with light oil generated in and recycled to the process. The slurry occupies about 20 per cent of the autoclave volume and is kept in suspension by mechanical agitation.

2. Ethylene is used to purge the air from the autoclave and then the ethylene pressure is built up to 440 psig.

3. The autoclave is heated to 160 F by circulation of hot water in the jacket. Reaction begins raising the temperature to 350-360 F and the pressure to about 520 psig. The reaction product is the catalyst for the ethlyene polymerization.

4. Reaction is then promptly killed by circulation of cold water through the jacket. This entire operation from the first addition of ethylene requires approximately 15 min.

5. When the temperature has fallen to about 240 F, ethylene at 880 psig is admitted and the oil polymerization commences. The autoclave temperature is held constant plus or minus 10 F by jacket cooling. Due to polymerization the pressure in the autoclave is below the ethylene line pressure until the autoclave is full of liquid when its pressure equals the ethylene line pressure.

6. At this point the ethylene supply is shut off and the pressure on the autoclave relieved at the top.

The above procedure is used in the preparation of oil A. To produce oil B the polymerization is carried out at 355 F with a somewhat lower yield. Impurities in the ethylene tend to lower the viscosity of the lubricating oil produced. Autoclaves of carbon steel are satisfactory.

The oil in the reactor is blown down into a batch separator for separation of the oil and catalyst layers. A small amount of methanol may be added to facilitate separation. The mixture is then centrifuged at 190-200 F, which separates the heavier catalyst complex from the oil. The oil next passes through a DeLaval centrifuge for further catalyst separation or may be passed directly to an autoclave for removal of the last traces of catalyst. Here 2 per cent methanol on the oil and lime dust are added to break down the catalyst complex and neutralize the acid from it. The treated oil mixture is passed through a filter press and is then ready for distillation.

The aluminum chloride catalyst from the centrifuging is reacted with water. The oil separated may be added to the main oil stream. The filter cake from the presses may be washed in place with light oil from the process for heavy oil recovery. The washings may then be added to the oil stream.

The ethylene liberated from the purging, venting, and degassing of the autoclaves, separators, centrifuges, and receivers is water washed, caustic washed and recirculated.

The methanol operations are carried out in vessels provided with methanol condensers and the vent gases from the condensers are water washed for methanol recovery.

The oil from the filter presses may be worked up by conventional means. Distillation removes about 15 per cent of light ends which is used in making up the catalyst slurry and as filter press cake wash oil. The topped lubricating oil is treated with fullers earth or the equivalent for finishing.

The oils so made are blended with natural lubricating oils and the blends are used principally as aviation oils.

J. H. Boyd.

Use of Synthetic Lubricants

Q Are synthetic lubricants employed in the compounding of commercial lubricants or greases? If so, in what quantities or proportions, in what viscosity ranges, and what specific properties of the final products are enhanced?—*M. L. V.*

Synthetic lubricating fluids are being used in compounding commercial lubricants. Although such applications as replacements for lubricating oils are largely industrial, Prestone motor oil is an illustration of a synthetic product that is being distributed for automotive use. This lubricating fluid consists wholly or partially of UCON fluids, which will receive further mention. Different varieties of synthetic lubricating fluids are also being used in the manufacture of lubricating greases, but such use, up to the present, is largely in lubricants for specialized applications.

Two types of synthetic lubricating fluids can be considered. The first is the class, largely of hydrocarbon origin, which have been prepared as substitutes for natural mineral oils. The second consists of various fluids that have been developed to supplement natural products because one or more characteristics of the synthetics are superior to the corresponding characteristics of the natural products. Fluids of both types have been used in the liquid state and also have been thickened to form lubricating greases. In the following, mention will be made of specific types that have been so employed.

Lubricating oils, which reached a commercial stage, were manufactured in this country in the thirties by polymerizing cracked wax distillates. Although such products had a better viscosity index than most natural products, it was reported that they did not have the thermal stability of most high grade natural products. The increasing value of wax, which led to a relatively high cost for such oils, led to discontinuing this process. Apparently such synthetic oils did not reach a commercial stage in the manufacture of lubricating greases.

The Germans manufactured a synthetic bright stock during the war by polymerizing ethylene. Propylene was also polymerized abroad. Even so, the proportional amount of such lubricants was not large compared with the total tonnage of lubricating oils used in Germany.

Polybutenes, of relatively high molecular weight (up to 100,000 in some cases) are used in small percentages in some lubricating greases as structure modifiers or to give the finished product a stringy or tacky nature. Such products break down in molecular weight with the application of either heat or shear.

A United States supplier manufactures and markets synthetic lubricating fluids, which are said to be polyalkylene glycols and derivatives. Such products, marketed under the trade name of UCON fluids, are available as water-soluble or water-insoluble products. The exact composition of the various products is not given but, since either ethylene oxide or propylene oxide are considered with either alcohols or glycols, some speculation as to the reason for solubilities can be made. If the ethylene oxide predominates, the final product tends to be water-soluble, while if propylene oxide predominates, the product will be more oil-soluble and less water-soluble. However, the terminal groups of the compounds also influence solubility. Some of the polymers may have hydroxyl groups on the ends and would therefore be water-soluble, but alkyl groups are attached in such positions the tendency will be toward oil-solubility.

According to Millett[3] a number of formulations of lubricating greases employ UCON fluids. Characteristics of five such products are given by this author, three of which contain lithium soap, one sodium soap, and the other fine silica as thickeners. The proportion of such thickeners is not given, but such lubricating greases probably contain from 8 to 19 per cent of thickener to produce a No. 2 NLGI grade of lubricating grease. One manufacturer of lubricating greases containing UCON fluids, offers 10 different grades. The difference in such products is mainly in the viscosity of the Ucon fluid present. Millett[3] lists one lubricating grease made from a fluid of 67 SSU viscosity at 100 F and 115 VI. Such a product is said to be usable over an operating range of — 90 to 250 F. Another lubricating grease contains a fluid of 1145 SSU viscosity at 100 F and 137 VI, which forms a product usable within a range of — 15 to 300 F. Other lubricating greases contain UCON fluids of intermediate viscosities.

Esters of various types have also been suggested as lubricating fluids. Some such esters, used either alone or in admixture with other lubricating fluids, are employed quite extensively in lubricating greases. The particular esters that are being used are those of dicarboxylic acids such as di-2-ethylhexyl adipate, di-2-ethylhexyl sebacate or di-2-ethylhexyl azelate. Such di-esters have very low pour points, that of the last mentioned being — 85 F. They are also much less volatile as temperatures are increased than are low pour point petroleum products. These di-esters lend themselves readily to thickening by soaps and therefore form satisfactory lubricating greases. Further, they can be inhibited against oxidation as readily as most petroleum oils.

Suitable di-esters for low temperature lubricating greases are priced now at 40 to 60 cents per pound and some of these compounds have been in short supply within the past few years. On account of the price and availability, searches continue for cheaper and more abundant esters. As a consequence, dihexyl pinate, and dioctyl pinate are being investigated. As late as the middle of 1952 these compounds had only been made in laboratory lots. While there is an abundance of raw material, the price in commercial amounts is expected to be about that of the esters mentioned above.

Silicon fluids are being used in lubricating greases with considerable success in some applications. The cost of such fluids is high. Also special techniques have to be employed to form lubricating greases from soaps and silicon fluids. Although all silicon fluids are not satisfactory lubricants, the proper ones are satisfactory at low speeds and reports show good performance in some cases at higher speeds. Silicon fluids do have better resistance to decomposition with heat than do some of the other fluids mentioned. Some use at 302 F and even 392 F for shorter periods, has been reported.[2]

TABLE 1.

Name of fluid	Kinematic viscosity centistokes 100 F	210 F	V.I.	Pour point F
Ucon-LB-140	29.8	5.9	147	—50
Ucon-LB-300	65.0	11.0	142	—40
Ucon-LB-550	119.0	18.5	140	—30
Di (2-ethyl hexyl) sebacate	12.75	3.36	170	—75
Di (2-ethyl hexyl) adipate	8.09	2.37	129	—85
Di (2-ethyl hexyl) azelate	10.5	2.98	188	—75
Polymethylsiloxanes				
DC 500 "A"	17.11	7.16		
DC 500 "C"	74.7	30.2		
DC 200 "E"	279	111.8		

Note: The freezing point of the Silicons is probably below —40 C. Polymethylphenylsiloxanes and polyphenylsiloxanes are also employed as lubricants.

The present cost of silicon fluids is about $4 to $6 per pound. As a consequence of the cost of both di-esters and silicon fluids, various combinations of synthetic lubricating fluids and even petroleum oils, have been employed in the manufacture of lubricating greases. Thus, a small percentage of lubricating oil is used together with a di-ester in some formulations. Also varying proportions of di-esters with silicon fluids are employed in some lubricating greases. This has an added advantage in that such mixed fluids are more compatible with soaps than are the silicon fluids alone.

The lubricating greases containing di-esters are largely manufactured to meet government specifications, such as MIL-G-3278, which is for general use on aircraft and for instruments. Such a product will permit operation of equipment at — 65 F and will lubricate anti-friction bearings operating continuously at temperatures as high as 250 F and for short periods as high as 300 F. Certain electric motors with silicon insulation will operate most economically at 300 F and lubricating greases containing silicon fluids will also serve at such temperatures.

The characteristics of some of the synthetic lubricating fluids are shown in Table 1. Papers given at a symposium on synthetic lubricating oils are printed in the December 1950 issue of *Industrial and Engineering Chemistry* and should be of interest to anyone desiring further information on this general subject. One of these articles by Larsen and Bondi summarizes the functional properties of the fluids which have been mentioned.

A recent article on "Performance of Synthetic Greases" by Booser, Baker, and Jackson,[1] states: "In the industrial field petroleum greases will continue to be used preponderantly for many years to come. The performance characteristics of high quality petroleum greases under conditions normally encountered in machinery are generally better than those of any synthetics, and the cost factor heavily favors the petroleum products."

B. & R.

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* * *

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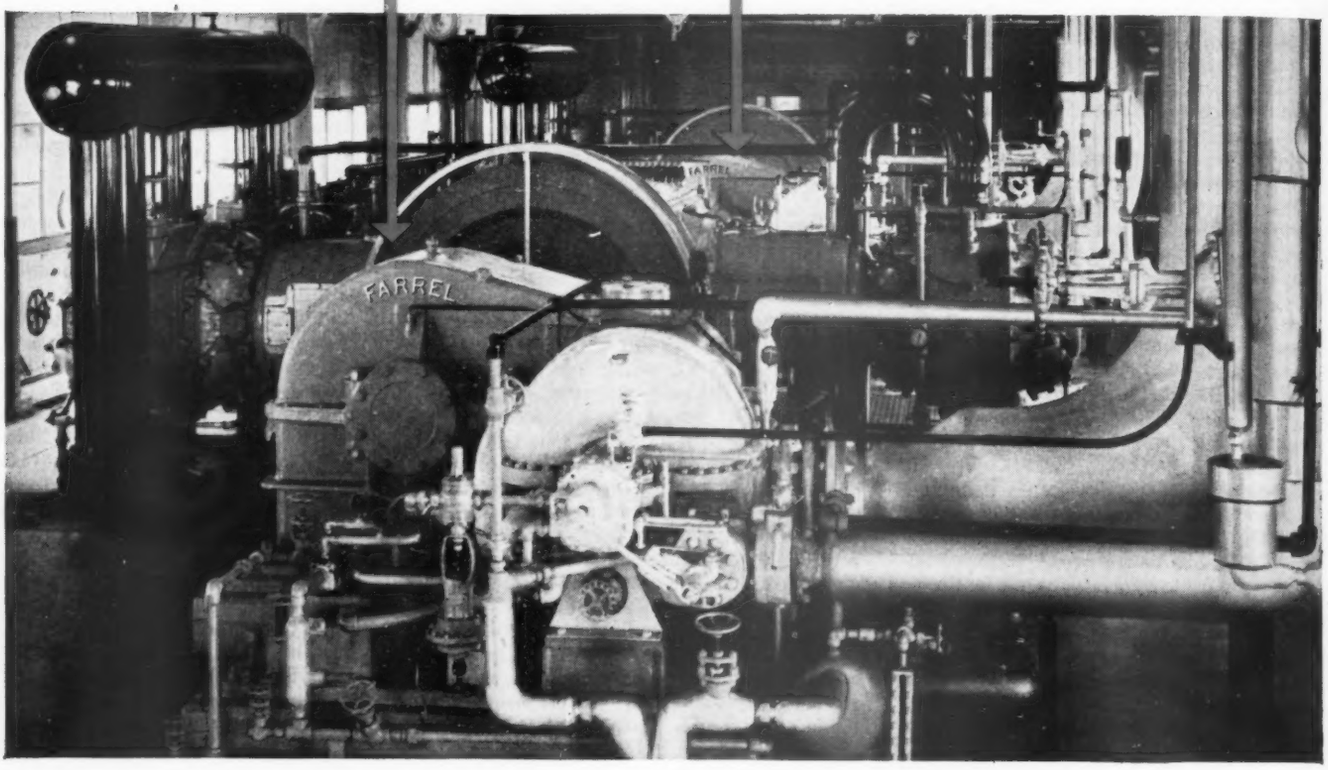

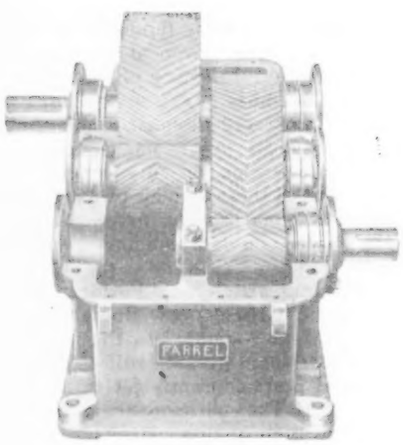

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DETERMINATION OF ASPHALT CONTENT OF A LUBE CRUDE OIL RESIDUUM

F. J. Higgins*

THIS method has been developed and successfully used by Continental Oil Company for the determination of the asphalt content of lube crude oil residua. It produces a constant asphalt figure, based on the crude, when the determination is made on any length of lube residuum. The asphalt is determined from the color of three or four naphtha solutions of a lube residuum, which have been contacted with different quantities of Filtrol contact clay and the colors of which fall within a prescribed color range. This is an empirical procedure which depends upon the fact that contact clay will deasphalt a crude oil residuum by adsorption, with subsequent decrease in naphtha solution color in proportion to the asphalt adsorbed.

The method was originally based on the observation that, for the several residua first investigated, a point was reached where additional clay added to a naphtha solution of a residuum affected the viscosity of the remaining oil relatively little. Colors of the oil-naphtha solutions were observed at this point of small viscosity change, and a color range was chosen which indicated this condition. The colors were measured with a Klett colorimeter using a number 54 green filter, standard Klett test tube, and naphtha for zeroing the instrument. The color range where little change in the physical properties of the deasphalted oil occurs is 120-150 Klett color. Material removed versus color of the oil solution was plotted. From this plot, the material removed at a Klett color of 135 was considered to be asphalt.

The specially prepared scale for plotting the data is printed on 8½ in. by 11-in. paper and has a linear scale along the 8½ in. side for plotting color and a restricted range of normal probability scale along the 11-in. side for plotting per cent asphalt. Ranges are 0.5 per cent to 10 per cent, 1.5 per cent to 15 per cent, 6 per cent to 30 per cent, and 15 per cent to 50 per cent.

The quantity of material removed is determined by evaporation of an aliquot of the clay deasphalted naphtha-oil solution to determine the per cent of oil. The difference between the original sample and its oil content is the material removed by the clay.

This method has been used by nontechnical personnel, having a high school education or equivalent, for the last seven years for routine crude oil evaluations. It has been very successful. The total elapsed time required for one determination is about eight hours. The person making the determination has some of this time free for performing other duties.

*Associate research chemist, Continental Oil Company.

Hot plate for naphtha evaporation.

Procedure

Weigh a 25-g sample of lube residuum into each of five weighed 1-liter Erlenmeyer flasks and warm in an oven at about 200 F. Add 375 ml of ASTM precipitation naphtha to the first flask and cool the solution to 95 ±2 F. Contact this solution with well-mixed Filtrol contact clay in small weighed increments agitating for one to two minutes after each addition of clay until a color break occurs. (The quantity of clay required varies from less than 100 per cent up to 1000 per cent of the 25-g sample for high asphalt residua. If it is observed that a large quantity of clay will be necessary to reach a color break, increase the size of the incremental clay additions.) Filter a portion of the solution and determine its Klett color using a Klett test tube, Klett No. 54 green filter, and ASTM precipitation naphtha for zeroing the instrument. From this quantity of clay relationship to color, select four different quantities of clay for the remaining four flasks, which will produce Klett colors differing approximately equally from each other and falling within the range of 70 to 250. Add one of the four predetermined weighed amounts of clay, respectively, to each of the remaining four samples in one addition. Place the flasks in a shaking machine for one-half hour. A vented neoprene stopper in each flask prevents loss of material by splashing. Allow the samples to settle for 15 min after shaking, then weigh. Decant approximately 100 ml of each solution into separate centrifuge tubes and centrifuge for 5 min at 1500 rpm. Determine Klett colors of each solution after centrifuging. Pour approximately 75 ml of the centrifuged solutions into weighed 250-ml Erlenmeyer flasks. Determine the weight of each aliquot and place the flasks on a 220 ±10 F hot plate. Evaporate the naphtha by pulling air with a vacuum through the flasks at a rate of 5 ±1 liters per minute. Continue the evaporation for hourly intervals until constant weights (within 10 mg) are reached.

The accompanying photograph illustrates well the specially designed hot plate that is used for the naphtha evaporations. The flask adapters fit conveniently into the vacuum connections attached to the back of the plate. Of course, any temperature-controlled hot plate can be used.

Calculate the per cent of deasphalted oil in the samples as follows:

Weight per cent of oil =

$$\frac{A}{B} \times \frac{C}{D\text{-}A} \times 100$$

Where A = weight of oil residue
B = weight of sample
C = weight of solvent = (weight flask plus clay plus sample plus solvent) — (weight flask plus clay plus sample)
D = weight of aliquot

per cent material removed = 100 per cent — per cent oil.

Plot Klett color versus per cent material removed. Then read the per cent asphalt at 135 Klett color, the standard color which has been previously established as the point where the material removed is considered to be asphalt.

In order to obtain a sufficient quantity of sample for inspection tests, a 250-gr sample of the residuum in 3750 ml of naphtha is contacted with the proper amount of clay to produce 9 solution color within the range 120-150 Klett color. After solvent removal by distillation and stripping with air, specific gravity, was content, and any other desired properties are determined. Volume per cent yield of oil is determined by multiplying the weight per cent of the deasphalted waxy oil by the specific gravity of the residuum and dividing by the specific gravity of the deasphalted waxy oil.

An example of the data obtained from several residua produced from one crude is tabulated below:

Residuum number	594	595	596	598	599
Volume per cent on crude	29.0	15.2	22.4	28.4	25.1
Gravity: API	23.8	21.1	22.4	23.4	22.9
Specific	0.9111	0.9273	0.9194	0.9135	0.9165
Viscosity, CS. at 210 F	19.60	64.57	31.20	19.51	24.65
Per cent clay, 250 g sample	145	292	177	152	164
Klett color, 250 g sample	127	133	129	124	122
Deasphalted oil weight per cent on residuum	92.66	86.73	90.69	93.07	91.98
Deasphalted oil gravity: API	25.4	23.9	24.9	25.5	25.1
Specific	0.9018	0.9106	0.9047	0.9013	0.9036
Deasphalted oil volume per cent on residuum (a)	93.62	88.32	92.16	94.33	93.29
Deasphalted oil volume per cent on crude (b)	27.15	13.42	20.64	26.79	23.42
Asphalt volume per cent on crude (c)	1.85	1.78	1.76	1.61	1.68
Average asphalt = 1.74 per cent variation from average asphalt	+6.4	+2.5	+1.4	−7.3	−3.2

Examples of calculations for residuum No. 594:

(a) Volume per cent of oil

$$= \frac{\text{wt per cent oil by sp. g. residuum}}{\text{sp. g. of oil}}$$

$$= \frac{92.66 \text{ per cent} \times 0.9111}{0.9018}$$

$$= 93.62 \text{ per cent}$$

(b) Volume per cent oil on crude

= volume per cent oil × volume per cent of residuum

= 93.62 per cent × 29.0 per cent

= 27.15 per cent

(c) Volume per cent asphalt

= volume per cent residuum — volume per cent oil

= 29.0 per cent — 27.15 per cent

= 1.85 per cent asphalt

P. 223.

DETERMINATION OF n-PARAFFINS IN COMMERCIAL PETROLEUM WAXES

H. Schindler* and A. Kinsel*

THE boundary separating the petroleum industry from the chemical processing industry is becoming increasingly more difficult to define. Should, for instance, alkylate for aviation gasoline be classified as a synthetic chemical or a petroleum product? And the same question could be raised with respect to aromatics produced by catalytic dehydrogenation. The closer approach to each other of petroleum and chemical industry has also changed the viewpoint from which the more conventional petroleum products are regarded. More and more often, attempts are being made to correlate chemical structure with functional properties, performance, and utilization of these products.

This development which began with the hydrocarbons used as motor fuels—because of their predominant importance and the relative ease of analysis and synthesis—is gradually being extended to lubricating oils and waxes. The difficulties of analysis, unfortunately, increase almost directly as a function of boiling point since the resulting increase in molecular weight permits the existence of a growing number of isomers. Consequently, for the higher boiling or residual products we have to content ourselves for the most part with a statement on the kind and quantity of hydrocarbon classes rather than give information on the actual individual hydrocarbons present. This, although not an ideal situation, is not as objectionable as it may appear at first glance because many of the functional properties are tied to the class of hydrocarbons and it appears to be of relatively minor importance what individual compounds make up the class.

This situation definitely exists in the case of petroleum waxes. The so-called "paraffin" waxes obtained from overhead distillates owe their useful properties to the fact that they are predominantly composed of n-paraffins. The microcrystalline waxes, on the other hand, which are distinguished from paraffin wax by tackiness, flexibility, and the ability to absorb oil and become plasticized, are composed largely of solid hydrocarbons with a structure different from those of the straight-chain compounds.

In the past, the differentiation between paraffin and microcrystalline wax has been made predominantly on the basis of differences in crystal structure either observed microscopically or by measuring the contraction of the wax on cooling under specified conditions as proposed by Kinsel and Phillips.[1] The "Crystallinity Index" calculated from the contraction according to this method has proved to be a highly useful test for the identification of waxes and the prediction of their behavior in various applications. Interesting correlations of wax composition and physical properties have been made by H. Gross and K. H. Grodde[2,3] and Karl Fisher[4] but have not found general acceptance in this country. All methods discussed, however, utilize empirical relations between hydrocarbon structure and physical properties and it appeared desirable, if possible, to determine wax composition more directly.

As the presence or absence of n-paraffins is the most important difference between paraffins and microcrystalline waxes, the determination of n-paraffins in a given wax would appear to be the most direct means for its classification. An analytical method for the determination of n-paraffins in gasoline, oils, and paraffin waxes based on the selective reaction of antimony pentachloride with hydrocarbons other than n-paraffins was published by W. Leithe[5] somewhat over a year ago and seemed useful for identifying petroleum waxes. Extensive experimentation with the procedure showed, unfortunately, that it was not suitable in its original form for use on commercial petroleum waxes. A slight modification in the technique, however, was all that was needed to overcome this difficulty, and the modified Leithe procedure should prove to be a highly useful tool for both the wax manufacturer and user in their attempt to obtain the correct product for a given purpose.

The original procedure as published by W. Leithe consists of dissolving the wax in carbon tetrachloride (CCl_4), allowing the solution to react with antimony pentachloride ($SbCl_5$) at 104 F (40 C), adding a definite amount of carbon tetrachloride to the carbon tetrachloride solution of unreacted hydrocarbons, decanting the solution from the sludge formed by the reaction with hydrocarbons other than n-paraffins, washing the solution with dilute hydrochloric acid, and determining the density of the carbon tetrachloride solution. The n-paraffin content of the solution and, thereby of the wax, is calculated from the difference of the density of this solution and the density of the carbon tetrachloride used as solvent.

In the procedure as published, the carbon tetrachloride solution after washing with dilute hydrochloric acid is settled and filtered through cotton. It was found that with commercial waxes, the settled and filtered solution still contains a fine suspension of sludge, dilute acid, etc., so that the n-paraffin content when run according to the original procedure is found to be erratic, as all suspended matter in the solution affects the density of the carbon tetrachloride solution and falsifies the conclusions drawn from the density determination. With pure hydrocarbons this difficulty does not occur and it is most likely for this reason that the original procedure did not make provisions for it. Complete removal of all suspended matter was achieved by centrifuging the washed and settled solution and consistent results were obtained when the density determinations were carried out on this centrifuged solution. The improvement obtained by the modification is shown by the results given in Table 1.

Although the data in Table 1 can be used to estimate the precision of the modified procedure this can be done more directly by double determinations

TABLE 1. Determination of n-paraffins in commercial petroleum waxes.

Sample	Original procedure, per cent n-paraffins			Modified procedure, per cent n-paraffins		
	Found	Calculated	Difference	Found	Calculated	Difference
Microcryst. Wax A	18.6	....	....	20.3	....	....
Paraffin wax A	80.0	....	....	98.8	....	....
50% Microwax A 50% Paraffin A	67.3	49.3	+18.0	56.4	59.6	−3.2
75% Microwax A 25% Paraffin A	76.6	34.0	+42.6	40.6	40.0	+0.6
25% Microwax A 75% Paraffin A	84.7	64.7	+20.0	81.7	79.4	+2.3
Paraffin wax B	75.3	....	....	70.0	....	....
50% Paraffin B 50% Paraffin A	92.7	77.4	+15.3	83.5	84.3	−0.8
25% Paraffin B 75% Paraffin A	91.5	78.8	+12.7	77.2	77.4	−0.2
75% Paraffin B 25% Paraffin A	85.3	76.5	+ 8.8	88.1	91.2	−3.1
n-decane	106.5	100.0	+ 6.5	106.5	100.0	+6.5
Microwax B	37.7	....	....	25.2	....	....
50% n-decane 50% Microwax B	65.1	72.1	− 7.0	65.1	65.8	−0.7
25% n-decane 75% Microwax B	46.0	55.0	− 9.0	46.0	45.6	+0.4

*Daugherty Refinery, a division of L. Sonneborn Sons, Inc., Petrolia, Pennsylvania.

TABLE 2. Precision of modified n-paraffin determination.

Sample	Per cent n-paraffins Run 1	Run 2	Average
Paraffin wax C	98.7	95.2	96.9
Microwax C	20.7	20.4	20.5
Microwax D	23.4	21.6	22.5
Paraffin D	90.0	90.0	90.0
Microwax E	20.7	20.4	20.5
Microwax F	20.1	19.8	19.9
Microwax G	24.6	24.6	24.6
Microwax H	26.7	26.7	26.7
Microwax I	20.0	21.0	20.5
Microwax J	22.8	23.8	23.3
Microwax K	19.2	19.2	19.2

Standard deviation: 0.92

on a series of samples. The pertinent data are listed in Table 2.

The data of Tables 1 and 2 indicate that the modified procedure is a reliable analytical tool. The details of the procedure are as follows:

Determination of n-Paraffins in Hydrocarbon Wax

Apparatus

50-ml flask, ground joint.

Reflux condenser, ground joint.

Pycnometer with cap on capillary overflow.

Water bath or equivalent.

Centrifuge.

$CaCl_2$ drying tube for condenser.

Reagents

Antimony pentachloride C.P.

Carbon tetrachloride C.P.

Procedure

Exactly 1 g. of wax is weighed into the flask, 5 ml of CCl_4 is added from a pipet and the reflux condenser whose vapor outlet is equipped with a $CaCl_2$ drying tube is attached to the flask. The flask is heated gently until the wax is melted. The flask is then immersed for 5 min in a water bath maintained at 104 F (40 C). Five milliliters of $SbCl_5$, measured from a graduate, is added to the wax solution and the mixture heated under reflux at 104 F for 3 hours.

After 3 hours the flask is disconnected from the condenser, exactly 25 ml of CCl_4 is added from a pipet, the flask shaken gently and the CCl_4 layer is poured as completely as possible into a separatory funnel, avoiding inclusion of the tarry matter. The CCl_4 solution is shaken with 100 ml of dilute HCl (2 vol conc. HCl, 1 vol water) for 2 min. The CCl_4 layer is run through a small pledget of cotton into a 50 ml test tube. The test tube (balanced by a test tube containing CCl_4) is centrifuged until the solution is entirely clear. (The color of the solution can be disregarded but the solution must be free from any turbidity; this is usually the case after 30 min centrifuging at about 2400 rpm.)

The clear CCl_4 layer is pipetted into a 25-ml pycnometer, the pycnometer kept in a water bath at 68 F (20 C) for 30 min. After capping the capillary the pycnometer is weighed as quickly as possible and the percentage of n-paraffins calculated as follows:

$$\% \text{ n-paraffins} = \frac{3000\ (A-B)}{\frac{B}{0.795} - 1}$$

A density of carbon tetrachloride used as solvent

B density of carbon tetrachloride solution after $SbCl_5$ treatment.

0.795 assumed density at 68 F of n-paraffins

Correlation of Crystallinity Index

As the modified method for n-paraffins seems to permit a simple and direct classification of petroleum waxes according to their composition, it was interesting to compare the evaluation of various waxes obtained by this method with the corresponding results of the Crystallinity Index procedure. It will be remembered that the Crystallinity Index determines the contraction of a wax on solidification under specified conditions. Waxes are rated according to the contraction since it is controlled by the type of hydrocarbons predominant in a wax, being large for paraffin wax and smaller for microcrystalline waxes. Accordingly, petroleum waxes with a Crystallinity Index above 105 are classed as paraffin waxes while those having a Crystallinity Index not higher than 80 are considered as true microcrystalline waxes, with the intermediate Crystallinity Indices assigned to mixed waxes. This classification was established empirically but, as will be shown below, is justified by the relation of crystal structure and wax composition.

The correlation of Crystallinity Index and n-paraffin content is shown in Table 3 and Fig. 1.

Inspection of the data indicates that a straight line relationship exists between the Crystallinity Index and the n-paraffin content for waxes containing more than about 35 per cent n-paraffins.

TABLE 3. Correlation of n-paraffin content and crystallinity index.

Sample	Per cent n-paraffins	Crystallinity index
Microwax L	16.5	61
Microwax C	20.5	73
Microwax D	22.5	81
Microwax B	25.2	76
Microwax M	32.4	83
Wax N	40.6	88
Wax O	56.4	92
Wax P	69.4	98
Paraffin wax A	98.8	105
Paraffin wax D	90.0	107

For waxes with a n-paraffin content below 35 per cent the relationship follows a curve and becomes, most likely, again a straight line of different slope for low n-paraffin contents. It would seem, therefore, permissible to assume that the crystal structure of waxes having a n-paraffin content above 35 per cent is that of the straight-chain hydrocarbons modified only slightly by the hydrocarbons of different structure. This ability of the n-paraffins—above certain concentrations—to impress their crystal structure on a system of other solid hydrocarbons and oil has also been observed when paraffin wax was, for research purposes, added to U. S. petrolatum.

In view of the fact that the crystal structure is only one manifestation of the molecular configuration of the hydrocarbons making up the crystals, it is reasonable to assume that other physical and also chemical properties follow the variations shown by the crystal structure. It is for this reason that there is close correlation between the n-paraffin content—an indication of the chemical composition—and Crystallinity Index—an indication of the physical structure—and behavior under service conditions for waxes.

The data in Table 3 and Fig. 1 also lend support to the empirical grouping of waxes according to Crystallinity Index as the break in the slope of the curve—which is indicative of the change in properties of the waxes—occurs at a Crystallinity Index of about 85, which is very close to the Crystallinity Index limit set for true microcrystalline waxes. Inversely, we can classify waxes with less than 35 per cent n-paraffins as true microcrystalline waxes because up to this amount of n-paraffins the properties of the wax are controlled by the branched-chain or cyclic solid hydrocarbons. Waxes with higher n-paraffin contents, may exhibit properties characteristic for microcrystalline waxes to some extent but will in general behave more like paraffin wax.

Although our knowledge of the chemical composition of microcrystalline waxes remains very meager, it appears that some increase in the understanding of the functioning of these waxes in various applications can be gained from the information provided by n-paraffin determination.

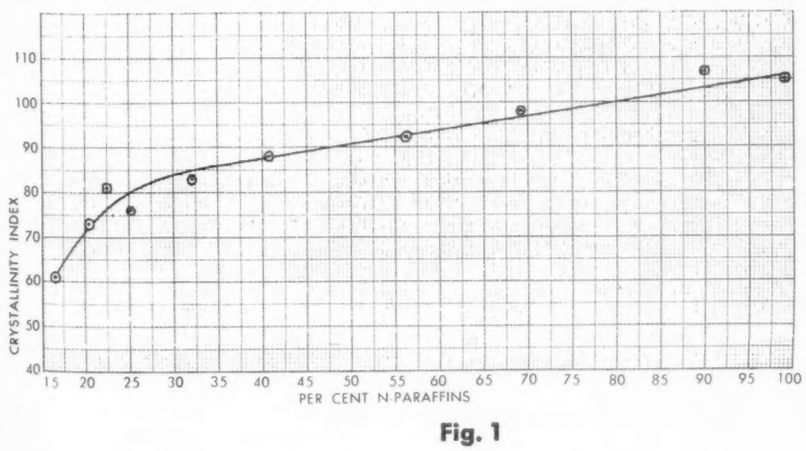


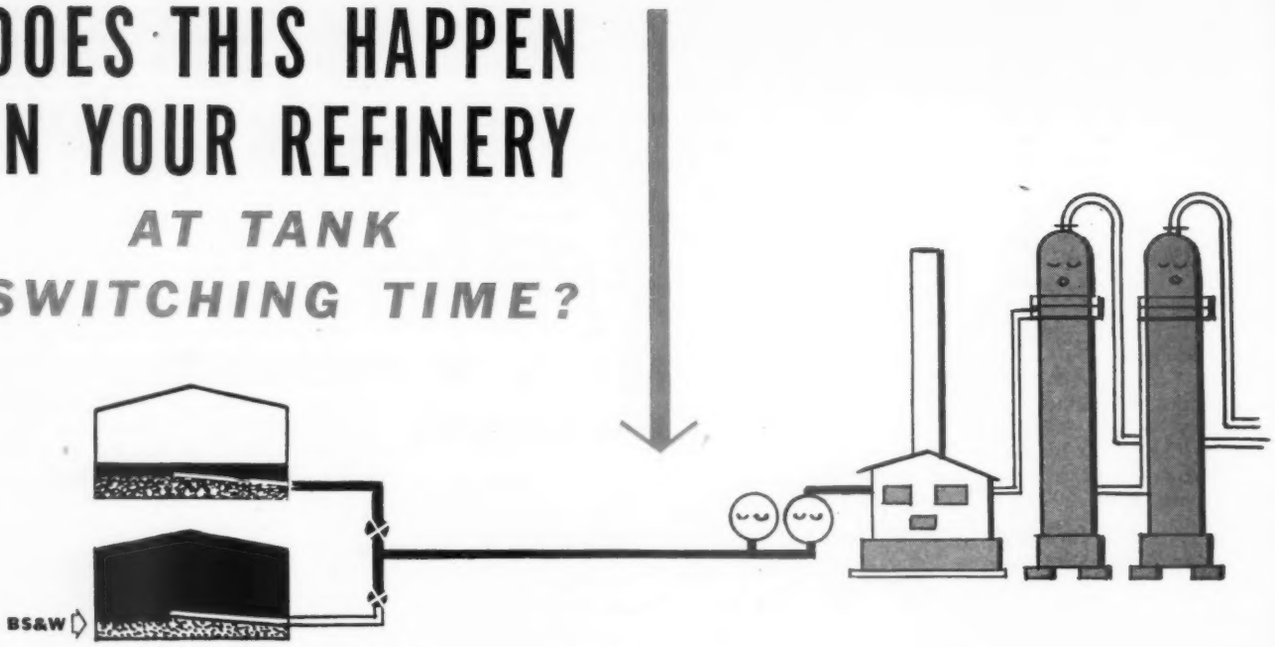
Fig. 1

References

1. A. Kinsel and J. Phillips, Ind. Eng. Chem., Anal. Ed. 17, 152 (1945).
2. H. Gross and K. H. Grodde, Oel und Kohle, 16, 419 (1942).
3. K. H. Grodde, Oel und Kohle, 8 Jahrg., No. 2, 61 (1950).
4. K. Fischer, U. S. Technical Oil Mission, Microfilm Reel 242.
5. W. Leithe, Anal. Chem. 23, 493 (1951). ★

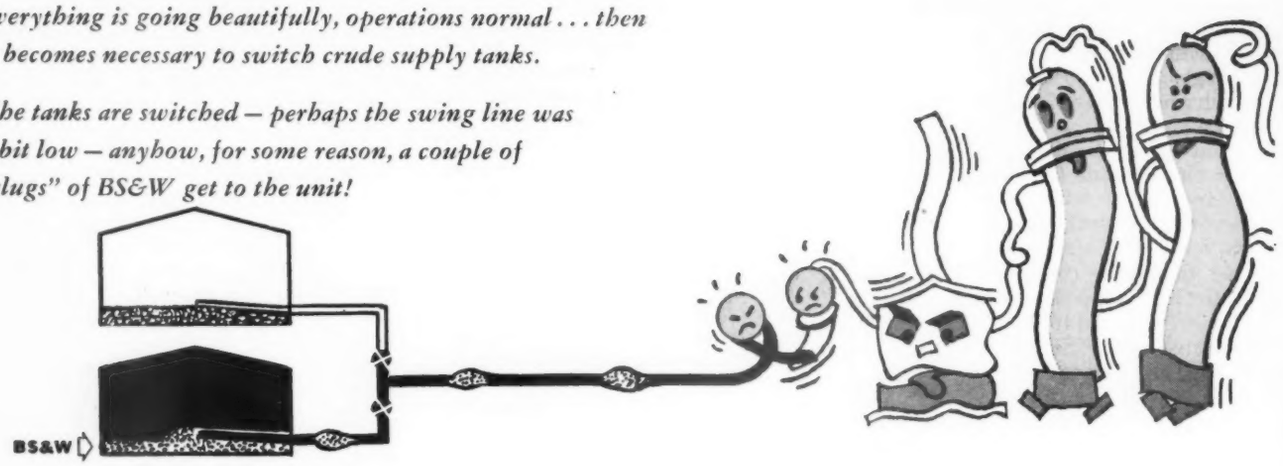
DOES THIS HAPPEN IN YOUR REFINERY

AT TANK SWITCHING TIME?



Everything is going beautifully, operations normal . . . then it becomes necessary to switch crude supply tanks.

The tanks are switched — perhaps the swing line was a bit low — anyhow, for some reason, a couple of "slugs" of BS&W get to the unit!



With Petreco desalting, this just can't happen. No BS&W, salts or solids get by a Petreco desalter. This benefits the refiner in two important ways:

First, the refining unit is not slugged with BS&W, salts and solids every time a tank is switched. Even if you accept only low-salt-content, pipeline specification crude, BS&W will accumulate. As long as there are BS&W settlings in storage tanks, "slugs" are possible, and as long as they are, you have a potential source of upsets, salt damage and solids accumulation.

Second, if you are careful when tanks are switched, severe damage can be delayed, perhaps avoided. But how is this done? Usually by *slowing- down, cutting-back, reducing throughput.* This means lower throughputs, fewer barrels of oil refined per calendar day. In the long run, running equipment at less than capacity is a costly practice, too!

Why not insure top refining throughput, as well as profitable efficiency, with Petreco desalting? Get Petreco's new booklet on tank switching, today. Write or call

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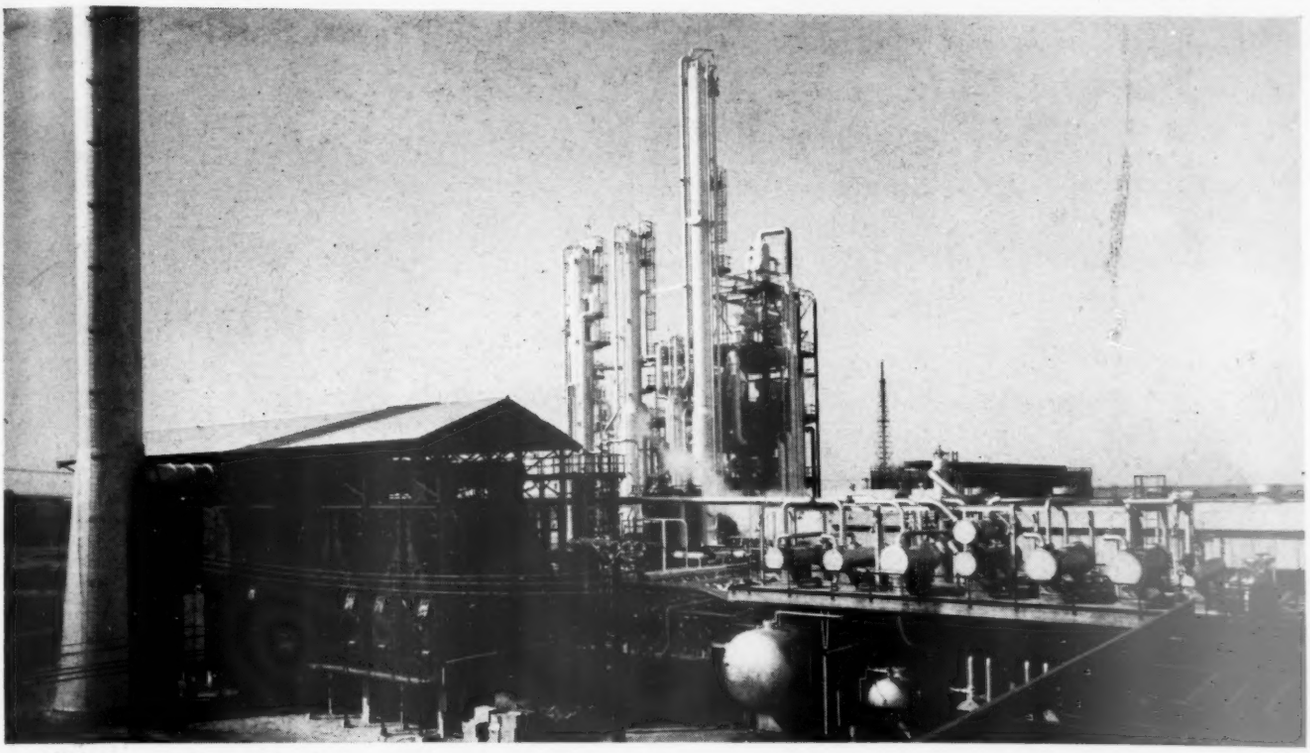
FUEL OILS: DESAPONIFICATION, ASH REMOVAL

PS 53-3



Gulf Oil Corporation's formal entrance into the petrochemical field was made when this ethylene plant was put into operation at the company's refinery at Port Arthur, Texas.

Petrochemical Capacities Hit New Highs

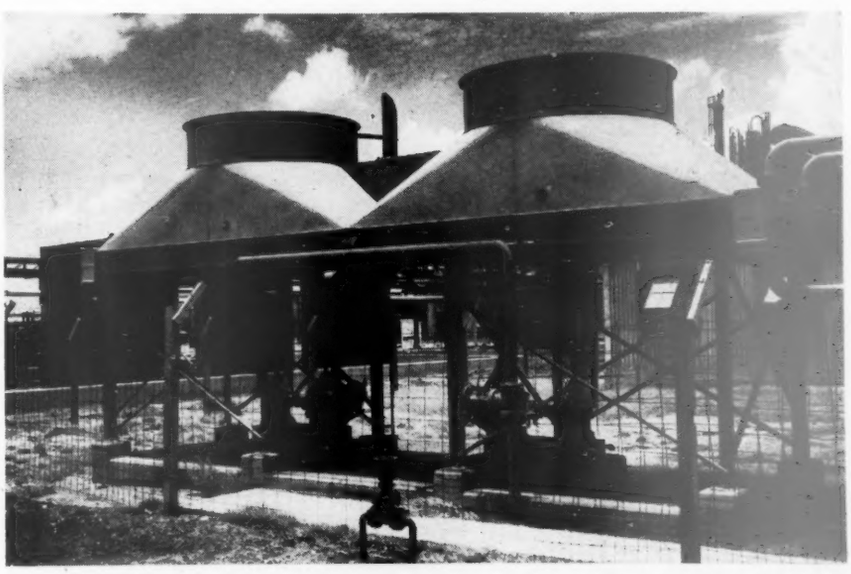
ARCH L. FOSTER*

EXCLUSIVE

ALTHOUGH the industry is moving too fast to permit crystallization of investment and/or expansion figures or the number of new plants or units building, all data now available indicate that between $\frac{3}{4}$-billion and $1 billion are being spent or are earmarked for expenditures during 1953. Reports and announcements of new ventures, or the expansion of old plants are coming in a steady stream. These round figures do not include the costs of more than 30 plants under design or building, costs of which have not been announced.

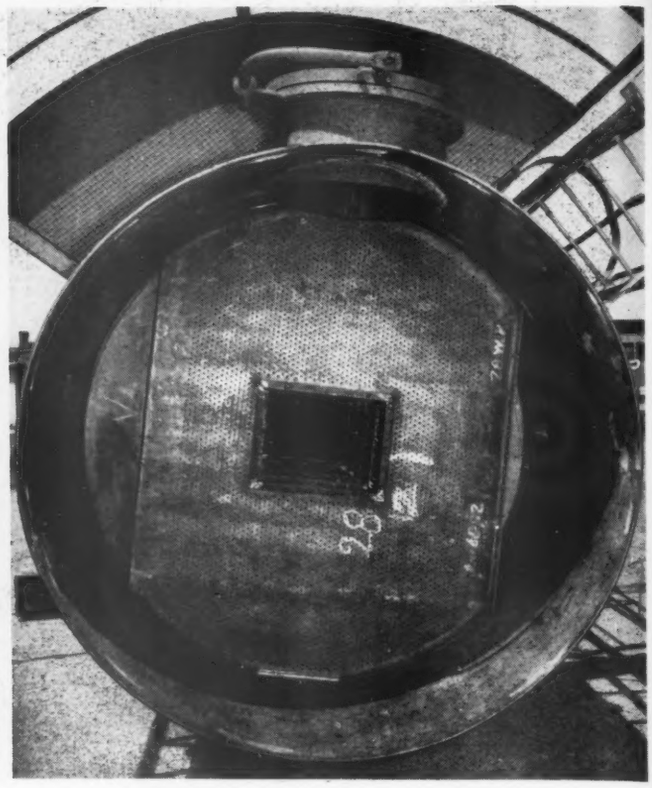
The petrochemical industry is maintaining its annual growth rate of 14 per cent or more, on each previous year, and is producing 70 per cent of the total organic chemical output of U. S. and Canada. (See J. H. Boyd and C. A. Rackus, this issue, Page C-3). Matters are moving too fast to determine with any certainty the relationship be-

*Editor, Refining & Petrochemical Edition.

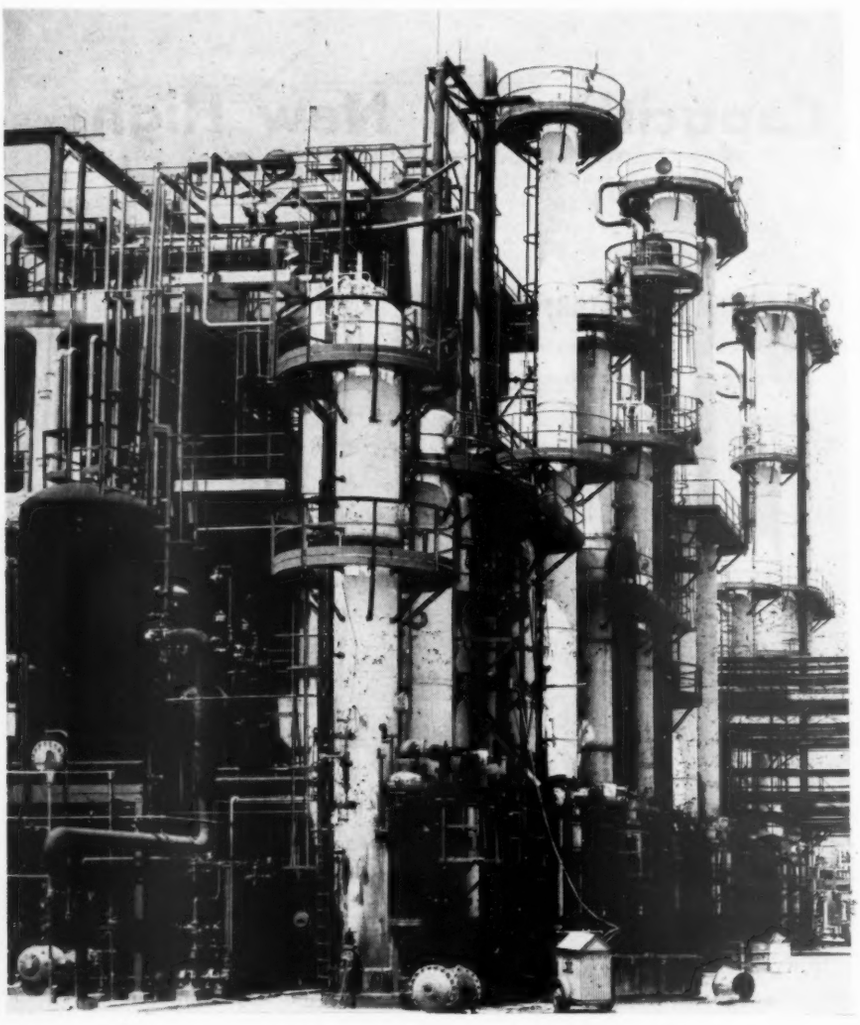


—Courtesy Celanese Corporation.

Jacket water coolers in a petrochemical plant, utilizing the same type of equipment employed widely in refining and natural gasoline plants.



Fractionating towers in which perforated plates are installed and perforated plate design employed in fractionating columns for petrochemicals.

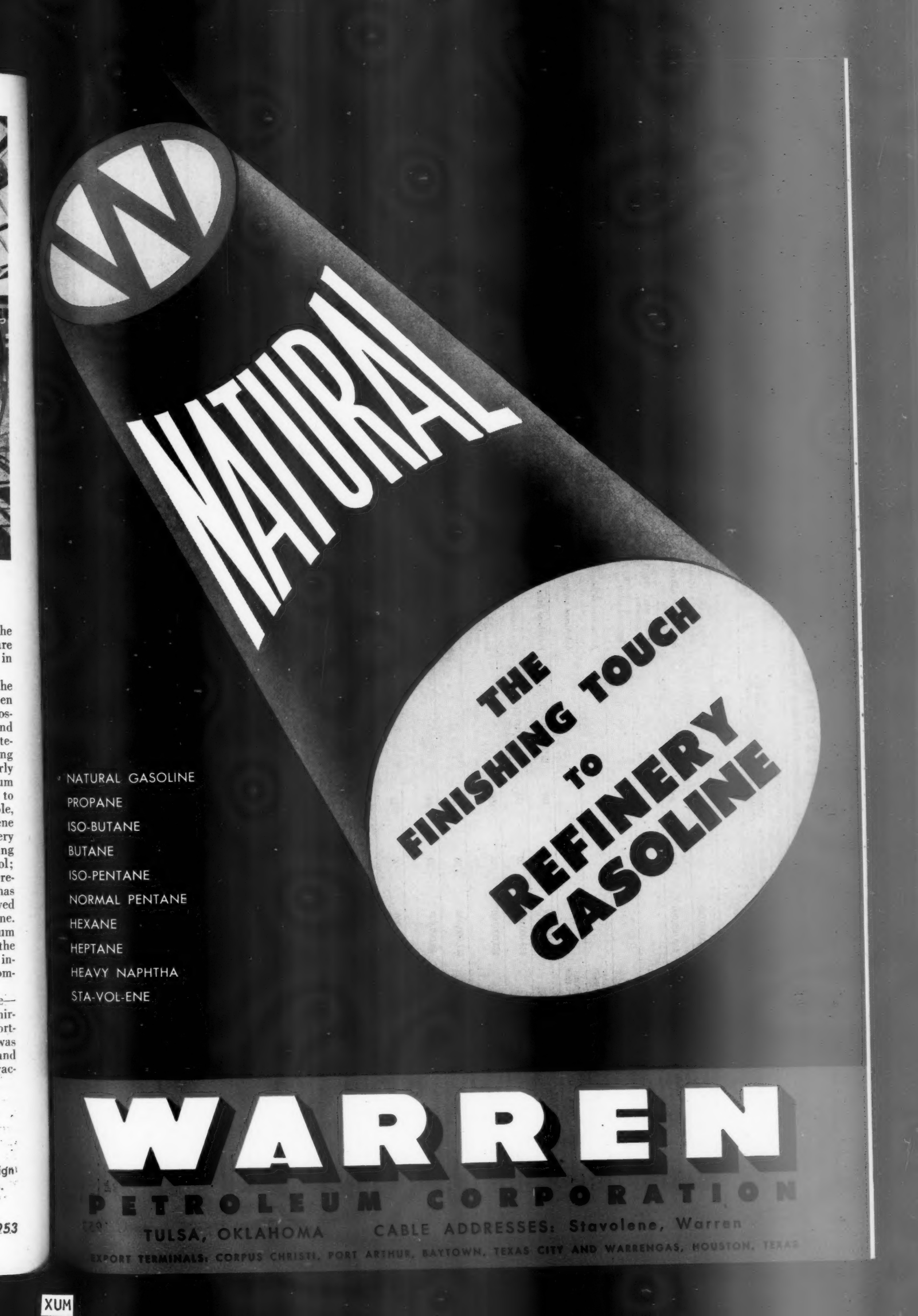


Portion of a Vinyl-Vinylidine plant that shows the complexity of design characteristic of petrochemical plants.
—*Courtesy Dow Chemical.*

tween supply of petrochemicals and the pyramiding demand, but indications are that the two are far from being in balance.

One of the major variables in the equation of the relationship between supply and demand is the fabulous possibilities in the fields of plastics and fibers. Already petrochemical raw materials and intermediates are making heavy inroads on products that formerly were obtained from non-petroleum sources. DuPont is converting rapidly to petrochemicals for nylon, for example, making intermediates from butadiene produced from butane or from refinery butylenes; for Dacron by combining terephthalic acid and ethylene glycol; and for Orlon from acrylonitrile. Heretofore styrene, or phenylethylene, has been a combination of petroleum-derived ethylene with coal-tar based benzene. Trend now is toward use of petroleum synthesized benzene, produced by the refining industry in very rapidly increasing amounts, to make styrene completely petroleum-derived.

Formerly nitration-grade benzene—for making nitrobenzene, (oil of mirbane), di- and tri-nitrobenzene, important chemical and dye intermediates, was purified laboriously by fractionation and chemical treatment of coal tar light frac-


NATURAL
THE FINISHING TOUCH TO REFINERY GASOLINE
NATURAL GASOLINE
PROPANE
ISO-BUTANE
BUTANE
ISO-PENTANE
NORMAL PENTANE
HEXANE
HEPTANE
HEAVY NAPHTHA
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SURVEY OF PETROCHEMICAL OPERATION IN 1953

Annual Refining Progress Number — April, 1953

Plant name and location	Status	Approx. plant investment	Total number of employees: Technical and administrative	Total number of employees: Clerical and non-technical	Approximate raw material capacity	Products Manufactured or Producible: Product	Products Manufactured or Producible: Amount capacity	Utilities Required or Installed: Electric Power kw.	Utilities Required or Installed: Steam Power bhp	Utilities Required or Installed: I-C engine power hp.	Utilities Required or Installed: Compressor capacity cu ft/hr or hp @ psig.
Allied Chemical and Dye, General Chemical Div., South Point, Ohio	Under construction	$4,000,000				Urea					
Allied Chemical and Dye, General Chemical Div., Orange, Texas	Under design	$5,000,000				Ethylene Oxide, mono, di, & tri Ethylene Glycols					
American Cyanamid Co., Fortier Avondale, Jefferson Parish, La.	Under construction	$50,000,000	100	400		Acrylonitrile, anhydrous ammonia.		9,000			
Brea Chemicals, Inc., Mercaptan plant, Wilmington, Calif.	Operating[1]					Methyl, ethyl, propyl & butyl mercaptans.					
Brea Chemicals, Inc., Sulfur plant, Wilmington, Calif.	Operating[1]					Elemental sulfur	50 T/day				
Brea Chemicals, Inc., Ammonium sulfate plant, Wilmington, Calif.	Scheduled[1] completion April1953					Ammonium sulfate	50 T/day				
Brea Chemicals, Inc., Anhydrous ammonia plant, Brea, Calif.	Scheduled[2] completion April 1954					Anhydrous ammonia	78,000 T/yr.				
Canadian Industries, Ltd. Edmonton, Alberta	Building (Oct. 1953)	$13,000,000	45	190	10,000,000 MCF/D, natural gas	Polythene flake	Present, 6000 T/yr.	4,200	4,000	3,900	1,360,000 CF/hr.
Carthage Hydrocol, Inc. Brownsville, Texas	Operating	$38,000,000[1]	62	376	100,000,000 CF/D, natural gas	(See Stanolind oil & gas report)		5,000	6,169		
Celanese Corp. of America, Chemcel—Bishop, Texas	Operating	$25,000,000	150	500		Acetaldehyde-acetic acid, formaldehyde, acetone, methanol, glycol, alcohols-esters, solvents					
Celanese Corp. of America, Pampa, Texas	Operating	$17,000,000	25	125		Acetic acid, acetic anhydride, solvents.					
Celanese Corp. of America, Edmonton, Alberta	Building	55,000,000	70	400		Same as Chemcel Plant, plus pentaerythritol and cellulose acetate.					
Celanese Corp. of America, Newark, New Jersey	Operating	$2,000,000	5	25		Tricresyl phosphate, and other plasticizers.					
Cities Service Oil Co., Oklahoma City,— Tallant, Okla.	15	85				Formaldehyde, acetaldehyde, methanol.	Product value $1,000,000/yr.				
Columbia Southern Chemical Corp. Barberton, Ohio	(No data made available)										
Consumer Cooperative Ass'n.... Lawrence, Kansas	Projected	$15,000,000				Ammonium nitrate Anhydrous ammonia 40% NH_4NO_3 solutions	83,000 T/yr. 13,000 T/yr. 13,000 T/yr.				
Continental Oil Co., Ponca City, Okla.	Operating					Benzene, toluene					
Continental Oil Co., Lake Charles, La.	Under constr. comp. fall of 1953					Benzene, toluene					
Continental Oil Co., Baltimore, Maryland	Operating				Benzene and propylene tetramer	Detergent basestock					
Continental Oil Co., Ponca City, Okla.	Under design comp. late 1954				Heavy petroleum fractions	Lubricating oil additives					
Continental Oil Co., Chicago, Illinois	Operating				Dodecyl–benzene	Water soluble sulfonates					
Cosden Petroleum Corp.	Operating	$3,200,000	3	16	4,500 B/D	Benzene Toluene Xylenes	150 B/D 400 B/D 400 B/D	750	1000	660	950,000 cu. ft/hr.
Cosden Petroleum Corp. Big Spring, Texas	Operating	$100,000	1	3	15,000 gal/mo.	Mercaptans, Cresylic acids	6500 gal/mo. 2500 gal/mo.				

[1] Part of operation by Union Oil Company's Los Angeles refinery at Wilmington, California. Products marketed by Brea Chemicals.

[2] Owned and built by Amoniaco Corporation — a non-affiliated company. To be leased and operated by Brea Chemicals.

SURVEY OF PETROCHEMICAL OPERATIONS IN 1953 — (Continued)

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SURVEY OF PETROCHEMICAL OPERATIONS IN 1953 — (Continued)

Annual Refining Progress Number — April, 1953

Plant name and location	Status	Approx. plant investment	Total number of employees: Technical and administrative	Total number of employees: Clerical and non-technical	Approximate raw material capacity	Products Manufactured or Producible: Product	Products Manufactured or Producible: Amount capacity	Utilities Required or Installed: Electric Power kw.	Steam Power bhp	I-C engine power hp.	Compressor capacity cu ft/hr or hp @ psig.
Cosden Pet. Corp., Big Spring, Texas	Building	$120,000	1	3	2,100 B/D	PIB	200,000 gal/mo.				
Dominion Tar and Chemical Co. Montreal East, Canada	Building					Ethylene, ethylene oxide, ethylene glycol					
Dow Chemical Co., Texas City, Texas	(No data made available)										
E. I. du Pont de Nemours & Co., Orange, Texas	Operating		357	1517	Cyclohexane, benzene, ethylene, natural gas	Polyethylene resin, nylon intermediate methanol		15,000	990,000	71,576	For Compressors
E. I. du Pont de Nemours & Co., Victoria, Texas	Operating		128	428	Natural gas, butadiene	Adipo-nitrile		5000 (Purchased)	240,000	6,919	For compressors
Esso Standard Oil Co., Chemical Products Dept., Baton Rouge, La.	Operating	(No data made available)				Alcohols, other olefin derivatives					
Foster Grant Company, Orange, Texas	Initial development stage					Styrene					
Goodrich-Gulf Chemicals, Inc., Orange, Texas	Initial development stage	(No data made available)									
Great Southern Chemical Corp. Corpus Christi, Texas	Operating		20	150	Butane, 1,000 B/D	Butylene concentrate	750 B/D				
Great Southern Chemical Corp. Corpus Christi, Texas	Building	$4,000,000		15	Natural gasoline 4,000 B/D	Benzene, toluene, xylene	1100 B/D				
Humble Oil & Refining Co., Baytown, Texas	Operating		12	220	Light naphtha, 30,000 B/D	Toluene Xylenes	1375 B/CD 2040 B/CD	5,600	10,400	9,000	9,500 hp.
Humble Oil & Refining Co., Baytown, Texas	Operating		12	220	Light naphtha, 30,000 B/D	Other aromatics Cyclohexane	700 B/CD 600 B/CD	5,600	10,400	9,000	9,500 hp.
Humble Oil & Refining Co., Baytown, Texas	Operating		12	220	Light naphtha, 30,000 B/D	Aliphatic solvents	1500 B/CD	5,600	10,400	9,000	9,500 hp.
Humble Oil & Refining Co., Baytown, Texas	Operating		9	275	Butane–butylenes, 7,000 B/D	Butadiene	130 short tons /CD	1,500	10,000	12,000	12,000 hp.
Humble Oil & Refining Co. Baytown, Texas	Building. Comp. 2nd qur., 1953		3	30	Xylene, 2,500 B/D	Paraxylene	66,000 lb/CD	1,500	0	0	1000 hp.
Standard Oil Co. (Indiana) Whiting, Ind.	Operating		1*	10*	Refinery sulfur gas, 35,000,000SCF/SD	Sulfur	55 tons/SD	300	1,410	0	0
Standard Oil Co. (Indiana) Whiting, Ind.	Operating		3	54	Virgin light naphtha, 11,200 B/CD	Benzene	1050	2,985	4,810	0	12,984 hp.
Standard Oil Co. (Indiana) Sugar Creek, Mo.	Building. Comp. early 1953		1	1	Polymer gasoline, 830 B/CD	C_7 Olefin concentrate	370 B/CD	0	120	0	0
Standard Oil Co. (Indiana) Wood River, Illinois	Operating		1	21	Polybutene plus diluent oil. 2,500 gal/CD	S A 41 & 52 motor oil detergent additive	3870 gal/CD	80	110	0	0
Standard Oil Co. (Indiana) Wood River, Illinois	Operating		1	4	Butane–butylenes 4,940 gal/CD	Polybutene	4930 gal/CD	175	84	0	150 hp.
Standard Oil Co. (Indiana) Wood River, Illinois	Building. Comp. early 1953		1	21	Polybutene plus diluent oil, 5300 gal/CD	Detergent additive	8220 gal/CD	170	240	0	0
Standard Oil Co. (Indiana) Wood River, Illinois	Operating		1	9	Tipentene & diluent oil, 1,780 gal/CD	Corrosion inhibitor additive	985 gal/CD	0	107	0	0
Standard Oil Co. (Indiana) Wood River, Illinois	Building. Comp. early 1953		2	57	Olefin, 234,000 lb/SD, and refinery gases, 8,400 lb/SD	Iso-octyl alcohol	30,000 lb/SD	120	883	0	424 hp.
Standard Oil Co. (Indiana) Whiting, Indiana	Building. Comp. early 1953		1 1	10 10	C_{12}–C_{15} Olefin, 601 B/SD, & benzene, 286 B/SD	Alkymer	602 B/SD	270	594	0	0

* Includes only personnel assigned to the units for operating, technical assistance and maintenance. The units are integrated with the refineries, with no separate chemical division. No additional administrative personnel considered chargeable to chemical operations. (S. O. Indiana).

SURVEY OF PETROCHEMICAL OPERATIONS IN 1953 — (Continued)

Annual Refining Progress Number — April, 1953

Plant name and location	Status	Approx. plant investment	Total number of employees: Technical and administrative	Total number of employees: Clerical and non-technical	Approximate raw material capacity	Products Manufactured or Producible: Product	Products Manufactured or Producible: Amount capacity	Utilities Required or Installed: Electric Power kw.	Utilities Required or Installed: Steam Power bhp	Utilities Required or Installed: I-C engine power hp.	Utilities Required or Installed: Compressor capacity cu ft/hr or hp @ psig.
Koppers Co., Inc., Port Arthur, Texas	Operating		10	52	Benzene, 9,500,000 gal/yr ethylene, 23,000,000 lb/yr	Ethylbenzene	80,000,000 lb /yr.	Purchased–100 K.W. Emergency unit.	30,000 lb/hr.	400	24,000 cu ft/hr. @ 100 psig
Mathieson–Mississippi Co. St. Louis, Mo.	Planning stage					Chemicals and acetylene					
Mississippi Chemical Corp. Yazoo City, Mississippi	Operating	$8,000,000	19	185	Gas, 2,400,000 SCF/D	Nitric acid Ammonia NH_4NO_3	165 T/D 120 T/D 210 T/D	195,555 Kw hr. /day	100,000 lb/hr. @ 150 psig	None	6,300 hp @ 15,000 psig (gas) 2,800 hp @ 110 psig (air)
Monsanto Chemical Co. Texas City, Texas	Operating[1]	$30,000,000 Expansion, 1952–53				Ethylene, styrene Vinyl chloride, (acrylonitrile, soon)					
Lion Oil Company El Dorado, Arkansas	Operating		119	970	Natural gas, 4,400,000,000 cu ft per year. Sulfur, 38,000 short tons /yr	Anhyd, NH_3 H_2SO_4 HNO_3 NH_4NO_3 Nitrogen solutions NH_4NO_3 Fertilizer	200,000 T/yr. 110,000 T/yr. 160,000 T/yr. 200,000 T/yr. 100,000 T/yr. 140,000 T/yr.	13,100	13,200	67,800	44,400 hp.
National Petrochemical Corp., Tuscola, Illinois	Building. Complete, June, 1953	$40,000,000 total	75 total	325 total	Natural gas, 400,000,000 cu ft/day, total	Propane i-butane n-butane Pentanes	350 M gal/D 25 M gal/D 70 M gal/D 15 M gal/D	4,180	100,000 lb/hr. @ 600 psig		78,000,000 cu ft/hr @ 250 psig 18,000,000 cu ft/hr. @ 250 psig
Extraction, fractionation		$13,000,000									
Ethylene cracking	Complete July, 1953	$7,000,000			375 T/day, ethane	Ethylene Hydrogen	375 T/D 21 T/D	1,700	300,000 lb/hr. @ 600 psig		9,000,000 cu ft/hr. @ 550 psig
Ethyl alcohol	Complete July, 1953	$7,000,000			284 T/D, ethylene	Ethanol, ether	12,500 gal/D	1,870			
Ethyl chloride	Complete Sept., 1953	$3,500,000				Ethyl chloride		680			
Sulfuric acid	Complete July, 1953	$1,000,000				66 Be. sulfuric acid	300 T/D	600			
Power house, water treating General services	Complete May–June, 1953	$9,600,000						4,440	600,000 lb/hr. @ 600 psig		
Loading, storage	Complete April July, 1953						13,500,000 gal.				
Natural Gas Odorizing Co. Houston, Texas	Operating	$300,000	5	20	500,000 gal/yr	Odorants	120,000 lb/yr. 180,000 lb/yr.	50	100		
Phillips Chemical Co., Cactus plant			124	537							
Anhydrous ammonia	Operating				4,015 M MCF natural gas	Ammonia	160,600 ST	5,800(4)	16,215	35,430	31,430
Nitric acid	Operating and contracted for				31,800 ST ammonia	Nitric acid	180,000 ST	6,200	265		9,800
Ammonium nitrate	Operating				52,500 ST ammonia 93,200 ST nitric acid 3,800 ST clay	Ammonia nitrate	118,600 ST	725	430		
Nitrogen solutions	Operating				13,300 ST ammonia 37,000 ST ammonium nitrate	Nitrogen solutions	55,200 ST	30	45		
Phillips Chemical Co., Adams terminal			90	275							
Ammonium sulfate	Operating and under design				96,700 ST ammonia 275,600 ST sulfuric acid	Ammonia sulfate	365,000 ST	1,105	7,100		
Menthylvinylpyridine	Operating				5,100 M lb acetaldehyde 477,000 lb ammonia	MEP (2) MVP (2)	100 M lb 2,000 M lb	715	1,370		
Anhydrous ammonia	Building, 4th quar.				3,775 M MCF natural gas	Ammonia	151,100 ST	6,885	15,400	20,200	19,800

(1) Government-owned. (2) Methylethylpyridine and Methylvinylpyridine. (3) Generated power. (4) Supplied from Plains plant butadiene section and included in butadiene section utility figures. ST—Short tons.

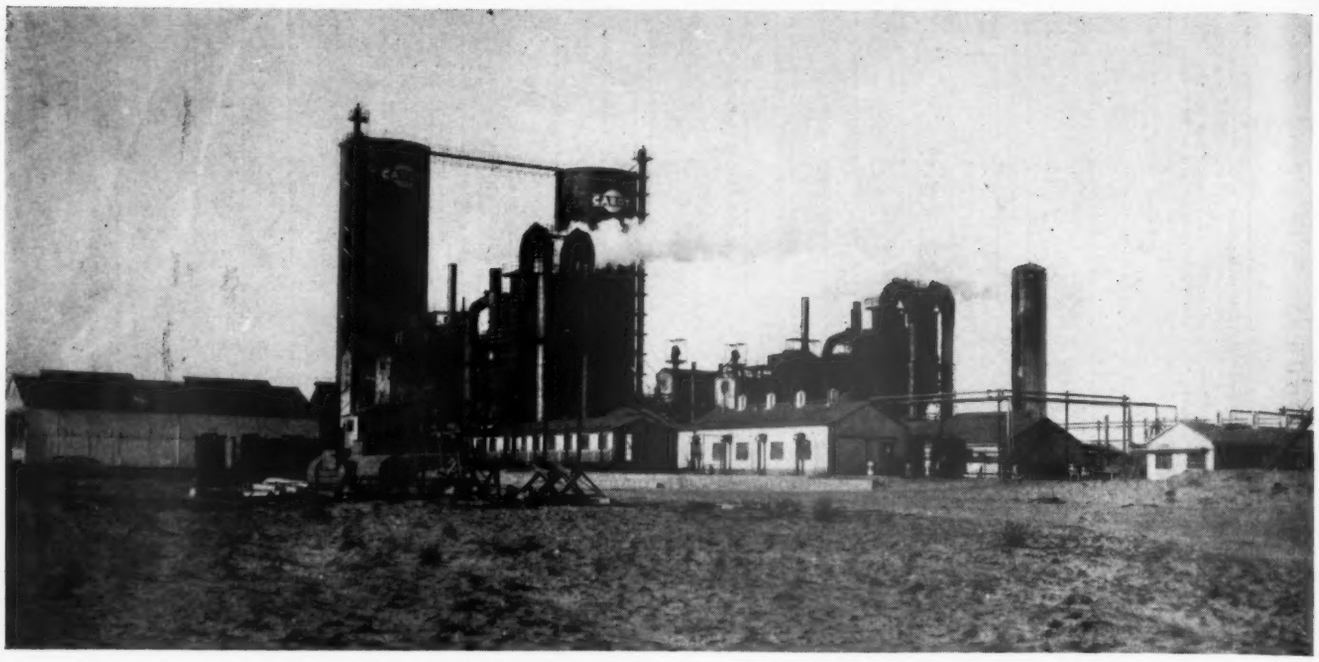
(1) Government-owned. (2) Methylethylpyridine and Methylvinylpyridine. (3) Generated power. (4) Supplied from Plains plant butadiene section and included in butadiene section utility figures. ST—Short tons.

SURVEY OF PETROCHEMICAL OPERATIONS IN 1953—(Continued)

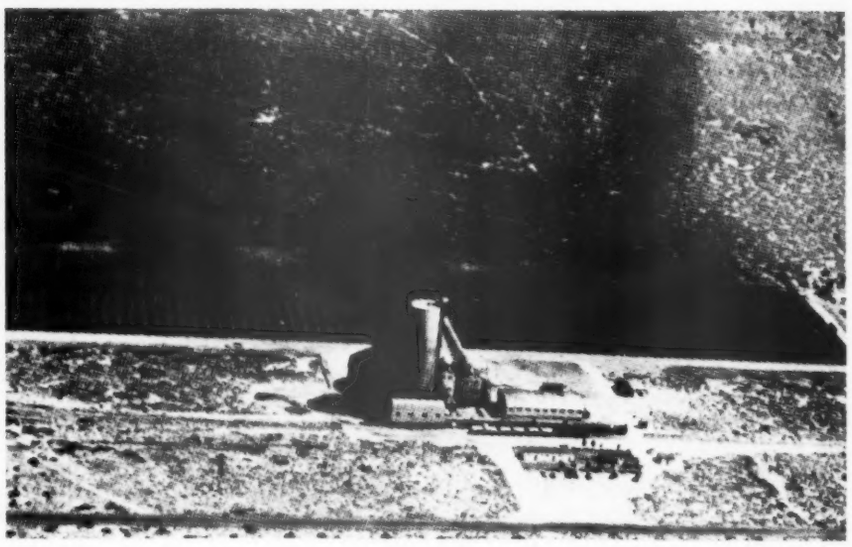
Annual Refining Progress Number — April, 1953

Plant name and location	Status	Approx. plant investment	Total number of employees: Technical and administrative	Total number of employees: Clerical and non-technical	Approximate raw material capacity	Products Manufactured or Producible: Product	Products Manufactured or Producible: Amount capacity	Utilities Required or Installed: Electric Power kw.	Utilities Required or Installed: Steam Power bhp	Utilities Required or Installed: I-C engine power hp.	Utilities Required or Installed: Compressor capacity cu ft/hr or hp @ psig.
Triple superphosphate	Building, 4th quar.				228,000 ST phosphate rock 137,600 ST sulfuric acid	Triple super phosphate	147,800 ST	1,000			
Phillips Chemical Co., Plains plant											
Butadiene	Operating		159	619	1,450 M bbl butane	Butadiene	71,200 ST	16,920 (4)	56,350	42,270	18,775
Copolymer	Operating		77	406	15,300 LT styrene 48,300 LT butadiene	Rubber	63,600 LT	3,400 (5)	1,605 (5)	2,300	2,300
Phillips Chemical Co., Philblack plant			62	340							
MAF	Operating				823,600 bbl gas oil	Philblack A	119,000 M lb	1,420			
HAF	Operating				1,215,300 bbl gas oil	Philblack O	171,000 M lb	2,605			
SAF	Operating				142,800 bbl gas oil	Philblack E	15,000 M lb	890			
Phillips Chemical Co., Sulfur plants											
Goldsmith	Operating		3	19	1,077 M Mcf hydrogen sulfide	Sulfur	36,500 LT	25	700	395	
Crane	Operating		1	5	539 M Mcf hydrogen sulfide	Sulfur	18,300 LT	10	350	50	
Phillips Chemical Co., Bartlesville office	Home office		150	117							
Rohm and Haas Company, Deer Park, Texas	Operating	$10,000,000*			Methane (natural gas)	Hydrogen cyanide Acetone cyanhydrin					
San Jacinto Chemical Corp., Houston, Texas	Operating	$5,000,000	13	68	Natural gas, 3,000,000 cu ft/D	Ammonia	70 T/D	5,000	750		5000 hp. @ 15,000 psig
Shawinigan Chemicals Ltd., Montreal East, Canada	Complete in April, 1953	$4,000,000			Cumene	Phenol Acetone	13,000,000 lb/yr.				
Shell Chemical Co., Houston, Texas	Operating				Hydrocarbons	Alcohols, solvents, glycerin, etc.					
Shell Chemical Company, Martinez, Calif.	Operating				Hydrocarbons	Alcohols, solvents, glycerin, etc.					
Shell Chemical Company, Dominguez, Calif.	Operating				Hydrocarbons	Alcohols, solvents, glycerin, etc.					
Shell Chemical Company, Pittsburgh, Calif.	Operating				Hydrocarbons	Ammonia $(NH_4)_2SO_4$					
Shell Chemical Co., Torrance, Calif.	Operating				Hydrocarbons	Butadiene					
Shell Company Company Ventura, Calif.	Building				Hydrocarbons	Ammonia, carbon dioxide					
Julius Hyman, (Shell) Denver, Colorado	Operating					Aldrin, dieldrin, specialties					
Socony-Vacuum Oil Co. and other refineries, Paulsboro, New Jersey	Operating				Various by-products	Sulfonates, cresols, phenols Na_2S-$(NH_4)_2SO_4$					
Stanolind Oil and Gas Company, Brownsville, Texas	Operating		22	101	145,000,000 lb/yr of water-soluble chemicals	Alcohols, aldehydes, ketones, acids	130,000,000 lb /yr.				
Sunray Oil Corp., Duncan, Oklahoma	Operating	$250,000	2	10	1800 B/SD of propane-propylene	Tetramer of propylene	250 B/SD		1,000	0	1,320 hp @ 225 psig
Texas Eastman Company, Longview, Texas	Partial Operating	$5,700,000			10,000,000 cu ft gas, 85,000 gal propane	Polyethylene, butyroldehyde 2-butyroldehyde Ethyl alcohol 2-Ethyl hexyl alcohol					

(2) Methylethylpyridine and Methylvinylpyridine. (4) Supplied from Plains plant butadiene section and included in butadiene section utility figures. (5) Partially government-owned and partially privately-owned on leased property.
* Data not furnished by company directly; taken from reliable published data.



Cabot Carbon Company's new furnace black plant at Big Spring, Texas, above, does not discharge carbon into the air. The Kermit channel black plant of the same company is shown below. Heavy clouds of black are typical of channel black process units.



tions. This grade is being made now in more than one refinery unit. The same is true of toluene, made to nitration specifications to make TNT, work-horse of high explosives, and other nitrotoluenes. Humble at Baytown is segregating xylenes, especially to purify the most desirable paraxylene for use in Dacron, and in other chemical syntheses.

In certain other fields tremendous strides have been made and others are scheduled. At least 25 separate units for the production of ammonia and its salts, and urea are under design or construction or have just gone on stream to produce fertilizers and as intermediates in chemical syntheses. Some of the ammonia produced is in turn oxidized to nitric acid to make fertilizer ingredient ammonium nitrate, also a minor ingredient of certain explosives. Lion Oil is doubling its capacity by building at Luling, Louisiana, spending a reported $31,000,000. Commercial Solvents, American Cyanamid, Oklahoma Fertilizer, Phillips Chemical, San Jacinto and Spencer in the south and southwest are building or expanding ammonia facilities, along with Mathieson, John Deere, and W. R. Grace. On the West Coast Shell Chemical, Rocky Mountain Chemical, Hooker and Union Oil of California will produce fertilizer and other ammonia products, or supply ammonia for those purposes.

In plastics and their intermediates Dow Chemical is one of the group of pioneers, accompanied by Monsanto. Dow is reported to have a larger percentage of its business in petrochemicals than any other company. Carbide and Carbon is credited with having done more for the petrochemicals industry than any other company, has a half-billion invested in this field including plastics, a large part of the total. Two fast-stepping comparative newcomers are Shell Chemical, older of the two, and Phillips Chemical, each the offspring of the oil company of the same initial name. Shell began its chemical activities largely on the Pacific Coast, did a great deal of important research and came up with, among many other things, synthetic glycerine from propylene through an ingenious synthesis that is still one of the recent chemical wonders. Late announcements indicate that Shell is contemplating taking over the entire remainder of the glycerin production goal of National Defense agencies, which reportedly would more than double its present production.

As indicated in the accompanying table, Phillips Chemical is in the production of ammonia and nitric acid, the nitrate and sulfate of ammonia, carbon black, sulfur, butadiene, and synthetic rubber, having taken over the entire Government facilities for the last two, connected with Phillips' refineries in the Texas Panhandle. It is natural that both Shell and Phillips should become involved in petrochemicals, with large refineries and reserves of crude, natural gas, and their components.

One of the possibly complicating factors in ammonia production, and one which may react to the advantage of chemical companies using ammonia as an intermediate, is the fact that under present price conditions chemical consumer prices for NH_3 are considerably higher than for the same product as a fertilizer; consequently all producers of ammonia are looking for chemical outlets, that may or may not depress the prices paid by chemical consumers.

One interesting development marking petrochemical advances is the subsidiary companies formed by petroleum and chemical companies, by two or more chemical companies, or by chemical or petroleum companies with agencies outside either industry, to develop petrochemicals along numerous lines. Usually one of these companies, normally the petroleum or natural gas company has residual materials, or byproducts for

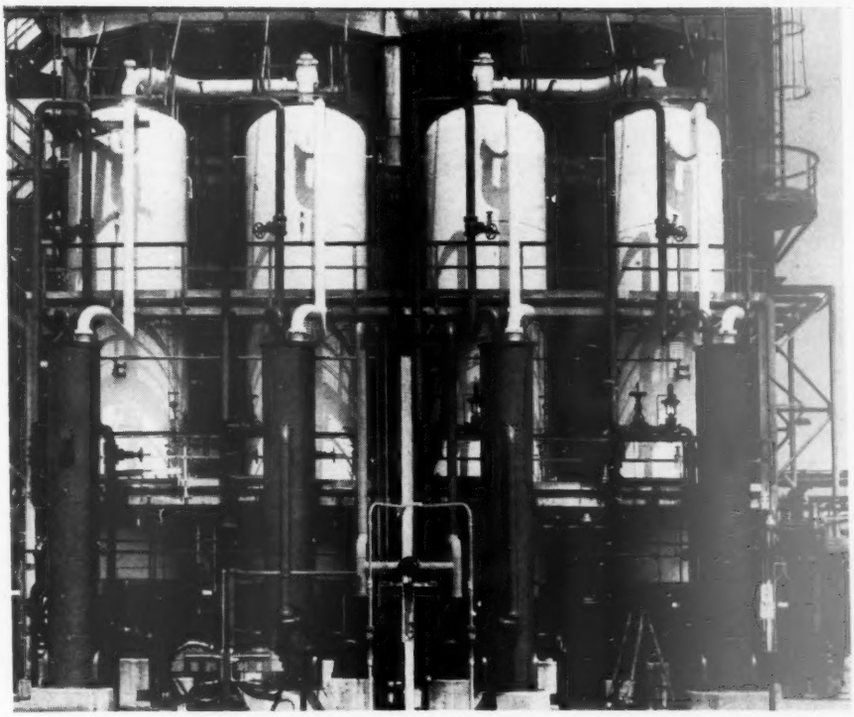
which markets must be found, the chemical company needs intermediates for going or for planned operations in their fields.

For example, recently an announcement indicates that Mathieson Chemical and Mississippi Chemical have joined forces to make chemicals and acetylene in a plant planned for the St. Louis area. Grapevine says this plant will use the Sachse process of German origin for the production of acetylene from methane. A great deal of work has been done on this process as the data on it have been available since World War II. General Aniline & Film Corporation has studied at length various reactions of acetylene with other organics at high pressures and a whole new field of expansion is said to be opening for this most reactive hydrocarbon derivative, formerly obtained only from calcium carbide via the electric furnace route.

Similarly American Cyanamid and The Texas Company formed Jefferson Chemical Company. Its new plant is situated at Port Neches on the Texas-Louisiana border in a spreading world of oil refining and petrochemicals, and uses refinery gases, olefins, etc., as raw materials. Texas Company has its largest refinery within a few miles, Atlantic, Gulf, Pure, Magnolia have big refineries nearby from which olefin byproducts may be drawn, water transportation no farther away than their own docks on the Ship Channel to the Gulf 20 miles south. Cyanamid needed the ethylene, alcohols, etc., making and to be made.

National Petrochemicals Corporation was established at Tuscola, Illinois, by National Distillers and Panhandle Eastern Pipe Line on the latter's big gas line to the northern cities areas. Products to be made are shown in the table, and it is considered a smart move to transport the raw material via pipe line to the center of consumption of the products, rather than to make the long haul paying for chemical transport. Several other company combinations are in operation or in the design-and-building stage, important parts of the industry's expansion trend.

The tabulated data in the accompanying table shows all of the authentic data now available on the companies listed. This report will be continued in succeeding issues until the industry has been covered as far as information may be obtainable. * * *



Courtesy Dow Chemical.

Petrochemical plants take on the look of analogous refining units.

PLANT AID

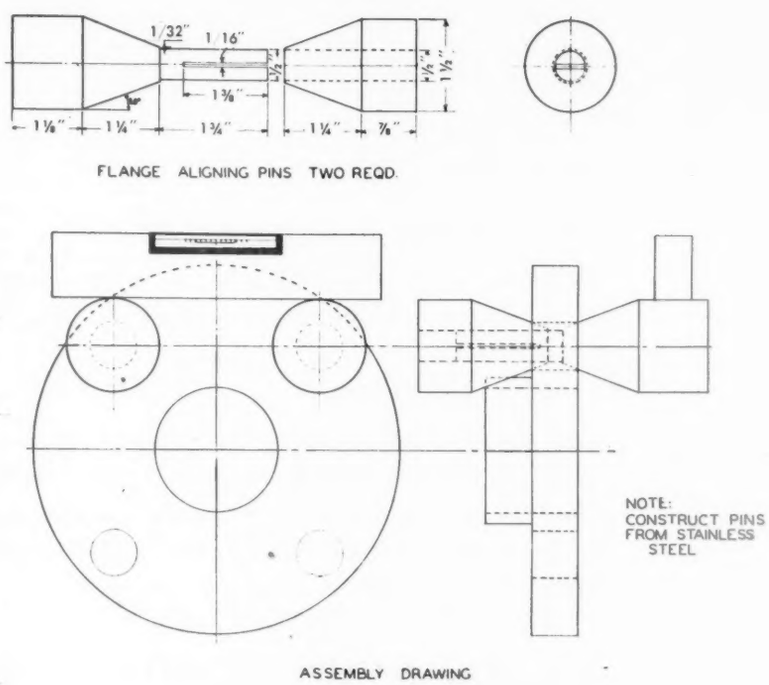
Two Hole Line-up Pins

KENNETH T. HENSON*†
OSCAR L. WATSON*‡

Used for positive two-hole alignment of all standard type flanges. Place each pin through two top holes of flange, push the two parts snugly together, beveled edges will bind against front and back of flange. Place level on top of pins and turn flange to perfect level and two hole. You are now ready to tack companion welding fitting on to flange knowing you are on perfect two hole. This prevents the necessity of having to double-check alignment.

Line up pins were made from stainless steel pump shaft by company machinist. As pins are made from discarded pump shafts, machinist's labor is the only expense. Time saved by the use of these pins would be very hard to estimate, but would be considerable over a period of a year.

*†The Shamrock Oil and Gas Corporation, welder, Sunray, Texas.
*‡The Shamrock Oil and Gas Corporation, machinist, Sunray, Texas.
[12]Class D, second prize, NGAA — Panhandle-Plains Regional Meeting, Amarillo.



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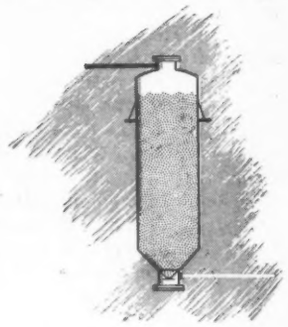
There's an Attapulgus or Porocel adsorbent to fit your process technique for removing odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates from process liquids or gases. Materials treated in principal applications are: motor oils and other lubricating, specialty, and technical oils; petrolatums and waxes; aviation and motor gasoline stocks; kerosene; diesel and heating oils.



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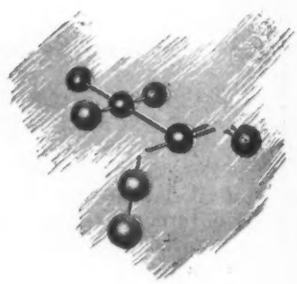
Attapulgus or Porocel sorptive minerals are recognized standards in desulfurization, reforming and isomerization systems—catalytic removal of unsaturates—conversion of sulfides to elemental sulfur—fluid catalyst applications—as catalyst carrier in copper sweetening processes.



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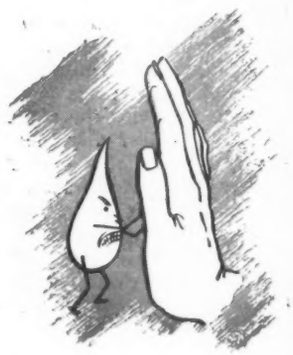

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Processing and Personnel Problems Discussed at NGAA

PROCESSING and personnel problems constitute the twin-horned dilemma for the natural gasoline industry, if we are to judge by the subjects and content of the papers presented before the Permian Basin Regional Meeting of the Natural Gasoline Association of America, February 27. The psychology of employee management, and the Three "E's" of safety in natural gasoline operations pointed out these fields of increasing importance vividly. The rugged problems of pump and engine operation and maintenance, the control of that ever-present headache, corrosion in water cooling systems, were presented to 400 members of the industry in Midland, Texas, the center of this currently most important region of Texas' gas and oil production.

Not of least interest was the discussion of conditions in the Federal Government as it pertains to communistic infiltration and subversive activities in Washington and elsewhere in this country, by Robert E. Stripling, chief investigator of the committee that unearthed the work of Alger Hiss and was responsible for sending him to prison as a perjurer. Stripling, who is informed thoroughly on the conditions "inside" the Federal Government, gave a great deal of information on conditions, and was scathing in his indictment and denunciation of what may be called Pinks and Fellow-travelers "in high and low places."

The "science" of personnel management is fast coming into its own, and W. C. Ford, industrial relations consultant of Houston discussed in considerable detail methods, problems, and approaches to the increasing number of difficulties faced by executive management in maintaining peaceful, efficient and progressive relations between employer and employee. The three E's of safety, says W. J. Rodgers, personnel and safety superintendent of the natural gas department, Magnolia Petroleum Company, are engineering, education, and enforcement. Engineering implies a safe working place, education means training in proper safety practices in working, while enforcement indicates adherence to those same safety practices. Great emphasis is placed on what Rodgers calls the Humanics of employee relationships, less on the mechanics of personnel management. The speaker outlined the type of handling that will bring out the willingness in employees to follow a leader; one who does not "push around" the ego of employees, who makes them feel better, lets them express themselves, who gives out encouragement and confidence in that same Ego. Quoting from Emerson, Rodgers indicated that in getting along with people it is fundamental that "What you are speaks so loudly I can't hear what you say!"

Due to improvements in the operation and design of gas engines since 1948, said W. R. Crooks of Cooper-Bessemer Corporation, such as precooling combustion air and other innovations, the spark-ignition gas engine has been developed to give 60 per cent more power and to handle 100 per cent more load, without increasing cylinder bore size or engine speed. By various systems of differing efficiency for cooling air at the intake, so as to increase the air-fuel quantity taken into the cylinder, designers have been able to increase engine ratings as well as to make savings directly in foundations and in building costs. Specific fuel consumption is lowered very importantly; combustion noises are minimized by improvement in burning characteristics; the heat load on all cylinder parts is lowered because of lowered maximum temperatures; at present Crooks stated that the cylinder assembly heat load is the limiting factor in the continuous power rating of engines. In the speaker's opinion combustion air precooling has demonstrated its real worth and its use will continue and increase in future.

The centrifugal pump is a precision instrument, says F. B. Applegate, of Pacific Pumps, Inc., in discussing new departures in their maintenance. The difference of one-half of one-thousandth of an inch means the difference between an adequate working clearance and a destructive rubbing contact in pump parts. The industry now is building pumps that operate at 7000-10,000 revolutions per minute, and that do, in a single stage what formerly was accomplished in eight stages. Most of the pump destructive forces are gathered under three heads, erosion, motion, and chemical action. Minimizing excessive velocity and turbulence by design does much to minimize erosion. Selection of pump and materials of its construction is fourth among the seven overall factors to be considered, the job being done in the light of the purchaser's records and experience. Pump location in the plant is important and is "up to" the plant engineer. Proper installation and alignment of the pump when installed goes far to take care of preventive maintenance problems. Selection of the proper man to operate the pump, "The low man on the totem pole" as the speaker said it, is all-important, because he inherits all the mistakes of the others and must try to correct them as far as possible.

Dissolved oxygen in cooling water is the primary cause of corrosion in cooling systems, says W. A. Tanzola, assistant technical director of W. H. and L. D. Betz, water specialists. Tanzola outlined in detail various factors in the solution of these problems, and his paper is given elsewhere in this issue.

W. A. Tanzola | W. R. Crooks | W. C. Ford | Robert E. Stripling

W. A. Tanzola, W. H. & L. D. Betz, discussed "Corrosion in Cooling Water Systems;" W. R. Crooks, Cooper-Bessemer Corporation, brought the operators up-to-date on "Precooling Combustion Air," in operation of gas engines; W. C. Ford, consultant on industrial relations, outlined problems in personnel handling, "Yardstick for Promotion of Employees," and Robert E. Stripling, Nemesis of Alger Hiss, gave the "low-down" on Communist infiltration in Federal Government.

F. B. Applegate | W. J. Rodgers | G. E. Kendricks | W. L. Phillips

F. B. Applegate, Pacific Pumps, Inc., showed the main principles in "Preventative Maintenance for Centrifugal Pumps;" W. J. Rodgers is an authority on accident and safety problems, and presented primary principles for handling these matters; G. E. Kendricks, El Paso Natural Gas Company, was presiding officer over the afternoon session, Permian Basin Regional meeting, NGAA, and W. L. Phillips, Phillips Petroleum Company, presided over the morning session.

News

Egloff Presented With Washington Award

Dr. Gustav Egloff, internationally known authority on petroleum chemistry and on scientific research in the petroleum industry received the Washington Award for 1953, one of the most important engineering honors in the world, at a dinner in Chicago, Illinois, February 23, 1953. The award was presented by Ovid W. Esbach, president of the Western Society of Engineers and dean of Northwestern University's Technological Institute, as reward "for distinguished leadership in petroleum research and development, in professional activities and in community services."

This award is based on recommendations by a commission representing a large group of engineering societies, the Western Society of Engineers, American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, American Institute of Electrical Engineers, and the American Society of Civil Engineers. Among the earlier recipients of this honor are listed Herbert Hoover, Charles F. Kettering, Henry Ford, Vannevar Bush, Arthur and Karl Compton, Orville Wright, Ralph Budd, Wilfred Sykes, and Henry Heald.

Dr. Egloff was born in New York City, received the Ph.D. degree from Columbia University in 1915, and three honorary D. Sc. awards, from Brooklyn Polytechnic Institute, Illinois Institute of Technology, and Philadelphia College of Pharmacy and Science. He holds some 300-odd patents on petroleum refining, petro-chemicals, and in allied fields, has published 11 books in his field, and hundreds of articles. More than 20 honors have been conferred on him by 34 countries, and he has been awarded honorary membership in a large number of engineering and scientific societies over the world.

Safety Record Set

Shell Chemical employees at the Torrance butadiene plant recently completed 2 years and 68 days of operation without a lost-time accident, according to Maarten Voogd, plant manager. This is the equivalent of 51 years without an accident in the home of an average family of four persons. Completion of this safety record by the plant's 375 employees marks the 800th accident-free day, or the equivalent of 1,660,287 manhours, since the butadiene plant was reactivated in December 1950.

Nitric Acid Capacity to be Raised at Cactus Plant

Construction of facilities to increase the present nitric acid capacity by 110 tons per day at Cactus plant, Etter, Texas, will begin immediately, according to an announcement by Phillips Petroleum Company. Present government-owned nitric acid facilities are operated under lease by Phillips Chemical Company, a wholly owned subsidiary.

The government-owned plant located at Etter, formerly known as Cactus Ordnance Works, was leased in 1948 by Phillips Chemical Company. At the time Phillips assumed operation, ammonia was the only fertilizer material being produced. Since then the company has doubled in size the ammonia production capacity and nitric acid production facilities were installed with Phillips Chemical Company continuing to operate both under lease from the government.

The Chemical and Industrial Corporation of Cincinnati, Ohio, is handling the process and design for Phillips under contract, and construction will be done by Chemical Processes, Inc., a wholly owned subsidiary.

Italian Refining Company

"CONDOR" S.p.A per l'Industria Petrolifera e Chimica incorporated in Italy has announced that its directors are: Prof. F. Guarneri, chairman; Dr. F. Kind, vice chairman; Ing. M. Mortara, managing director; Dr. G. de Fischel; Ing. C. Ingoglia; Ing. C. A. Miranda; Ing. B. Nogara; Ing. C. Pesenti; Dr. M. Spada; M. Sulfina, and Ing. G. Valerio. Main office of the company is Pantanedo di Rho (Milan) Italy.

Principal plant, situated at Pantanedo di Rho consists of the refinery having a capacity of 12,600,000 bbl per year, with a 15,000 bbl per day TCC unit. Crude will be supplied to the refinery through an 81-mile 12¾-in. pipe line from Geonoa Genoa-Fegino.

New Research Technique For Engine Deposits

A new research technique for studying engine deposits in motor cars was announced in a paper delivered by Dr. Harold P. Landerl and Dr. Bernard M. Sturgis, chemists of E. I. du Pont de Nemours and Company, Inc., before the 123rd national meeting of the American Chemical Society in Los Angeles recently. The paper was presented by Dr. Landerl.

The new procedure for study of combustion chamber deposit formation involves the use of motor fuel containing tetraethyl lead, which is radioactive.

Motor Gasoline Survey Out

The national average antiknock values of both regular and premium gasoline sold at United States filling stations last summer was nearly as high as the record values attained during the winter of 1950-51.

This was one of the findings of the semi-annual motor survey report released by J. J. Forbes, Director of the U. S. Bureau of Mines.

Octane ratings of gasoline sold last summer in areas served by the Bureau's Region VI were:

	Research method		Motor method	
	Premium	Regular	Premium	Regular
Northwestern Missouri, Northern Kansas	89.7	82.5	81.4	77.7
Southern Kansas, southwestern Missouri, western Arkansas, Oklahoma, and northern Texas	90.1	82.8	82.1	78.3
Southern Texas	90.1	84.1	83.8	81.2
Southwestern Kansas, Panhandles of Texas and Oklahoma, western Texas	88.8	80.0	81.4	76.3
Louisiana, eastern and southern Arkansas	91.1	84.6	82.6	79.1

Shell Plant Adds to Nation's Benzene Output

A multi-million dollar integrated "platforming" and aromatics extractive distillation plant, which will add about 10 per cent to the domestic output of benzene plus a large volume of toluene, has just been put "on stream" at its Houston, Texas, refinery, Shell Oil Company announced recently.

Toluene is vital to the defense program. It is the last "T" in TNT and a component of high-octane aviation fuel, as well as an ingredient of dyes, cleaning agents, enamels and inks.

Yearly output will exceed 19,000,000 gal of benzene and 33,000,000 gal of toluene. Aromatic and non-aromatic by-products of the plant are blended into aviation gasoline, motor gasoline and special products.

The installation, largest of its kind in operation in this country, uses an extractive distillation process developed by Shell. This process, in a plant recently completed by Atlas Processing Company, has proved remarkably efficient in yielding 99.9 per cent of benzene recovery. Corresponding over-all plant recovery after treating the benzene to nitration quality is 98 per cent.

Refiners Asked to Add To Lubricating Oil Output

The Petroleum Administration for Defense has asked the oil industry to continue its efforts for increased lubricating oil facilities over the next three years. It announced that it has asked the industry to produce 194,000 bbl a day by the end of 1955.

PAD also reported that refiners had a production capacity of 178,000 bbl of lubricating oils a day on January 1, 1952, and presently scheduled expansion will boost capacity to 182,000 bbl a day by next January 1.

PAD Returns Butylene Output From Three Plants to RFC

Butylene production from three plants previously under directives to supply this material for the aviation gasoline program has been restored to the Reconstruction Finance Corporation for the synthetic rubber program, Deputy Petroleum Edministrator J. Ed Warren announced.

Restoration of the butylene production to RFC without affecting aviation gasoline output is now possible, Warren said, because arrangements have been worked out with a number of petroleum refiners for replacement of the material with an equivalent amount of codimer—a liquid produced from butylene which is equally suitable for aviation gasoline manufacture.

Petrochemical Exhibit for International Exposition is planned by Leroy Donald, Isaac Drogin, W. B. Way, John A. Britton, Jr., Kent Kimball, and Miller W. Conn. This is part of the oil show to be held May 14-23 in Tulsa, Oklahoma.

Gold watches were awarded to three Standard oil development chemists recently upon attainment of 100 U. S. patents each. They were: Dr. Louis A. Mikeska, Dr. William J. Sparks, Willard C. Asbury, vice president, who made the awards, and David W. Young.

New IPE Exhibit Planned Around Petrochemicals

The first petrochemical exhibit at the International Petroleum Exposition in Tulsa, Oklahoma, May 14-23, is being planned. Miller W. Conn, manager, market development division, Phillips Petroleum, is in charge of the exhibit.

Sub-committee consists of Leroy Donald, manager, chemical sales, Lion Oil; Dr. Isaac Drogin, director of research, United Carbon, W. B. Way, exposition manager; John A. Britton, Jr., director, Enjay Company; Kent Kimball, consulting geologist, executive secretary of the overall Scientific and Technical Committee.

Sarnia Refinery to Undergo Expansion

A construction program costing about $6,000,000 was announced by Dr. J. L. Huggett, general superintendent of Imperial's Sarnia refinery. Three new projects were listed by Dr. Huggett: a quality control laboratory, a mechanized packaging and shipping plant and centralized mechanical shops.

Dr. Huggett stressed that the new facilities were in addition to the $14,000,000 construction program just being completed at the refinery, which includes Canada's largest catalytic cracking unit and an atmospheric and vacuum distillation unit that is the largest refinery unit of any kind in Canada.

California Refining Will Expand Barber Refining

California Refining Company has awarded a contract to Catalytic Construction Company to handle the mechanical work in connection with the turnaround of that company's Houdriflow catalytic cracking unit and alkylation plant at Barber, New Jersey.

The Barber, New Jersey, plant produces aviation gasoline. California Refining Company is a subsidiary of Standard Oil Company of California.

Houdry Sues Socony-Vacuum on Cat-Cracking Patents

Twenty-two million dollars is a lot of damages, but that is the approximate value of the injury the Houdry Process Corporation asserts it has sustained by Socony-Vacuum Oil Company's licensing catalytic cracking processes which Houdry says infringes its patents in this field. Thus the first great patent litigation of catalytic cracking processes gets under way, 15 years after the first successful catalytic cracking unit was discussed before a large body of refining technologists in public meeting. In November, 1938, Arthur E. Pew, then refining vice president for Sun Oil Company, presented a paper before the refining division of the American Petroleum Institute in Chicago, in which he revealed detailed data on the original Houdry fixed-bed cat-cracking unit that had been operating for a considerable period of time at Sun's Marcus Hook refinery.

Since 1949, the Houdry complaint states, Socony has been licensing processes that are designed on technological data supplied to Socony by Houdry for use only in Socony's own refining operations. The suit is based on three claims, violation of trust and confidence, breach of contract and infringement of patents. It is claimed also that Houdry, at an undisclosed date, paid to Socony $2,165,000 covering "all costs and expenses incurred by Socony in developing" the Thermofor catalytic cracking process. This original process was licensed to the industry in a large number of units during and immediately after the end of World War II, it is stated.

To introduce improvements in catalytic cracking, over the old Houdry fixed-bed process, Houdry developed the process now known as Houdriflow, which includes a reactor zone superimposed on a catalyst regenerator zone, and with a vapor or gas lift arrangement for carrying regenerated catalyst upward to the reactor level. This process was announced in 1948, and 16 units are now licensed under its patents, it is stated. The following year Socony, so it is claimed by Houdry, offered for license a moving-bed process with many points similar to those employed in Houdriflow, and that this process is offered for license at a rate 60 per cent below that set by Houdry for its process. Socony had a right to utilize the Houdry patents and know-how in its own refineries, but no licensing authority or rights. Until 1950 Socony Vacuum Oil Corporation was a major stockholder in the Houdry Company.

Houdry asks assignment of a number of patents it claims were developed by Socony for Houdry and paid for by the sum mentioned above, perpetual injunction against Socony-Vacuum's actions claimed, and treble damages—typical procedure in such suits—for patent infringements.

Suit was filed in U. S. District Court, Philadelphia, Action No. 14893, late in February.

British Refineries Damaged By Recent Storms, Floods

Oil refineries in the vicinity of the Thames River mouth have been hard hit by the recent storms and floods, according to advices received. The new refinery of Anglo-Iranian Oil Company at Kent, now under construction, was damaged severely and work was halted for a time, delaying its completion for a considerable time, not yet able to estimate how long, officials say. Vacuum Oil's Coryton plant suffered the greatest damage, along with Esso's Purfleet plant and Shell's big Shellhaven refinery. The Coryton plant has the only Thermofor Catalytic cracking unit in all England, although that plant is devoted largely to lubricating oil manufacture. With sea water five feet deep in some places in these plants, strenuous efforts are being made to close the breaks in the seawall at that location. Monetary value of the damages has not yet been estimated by Anglo-Iranian Oil personnel.

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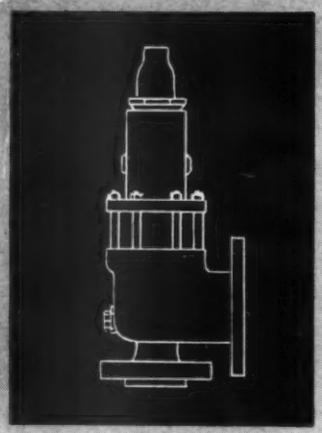

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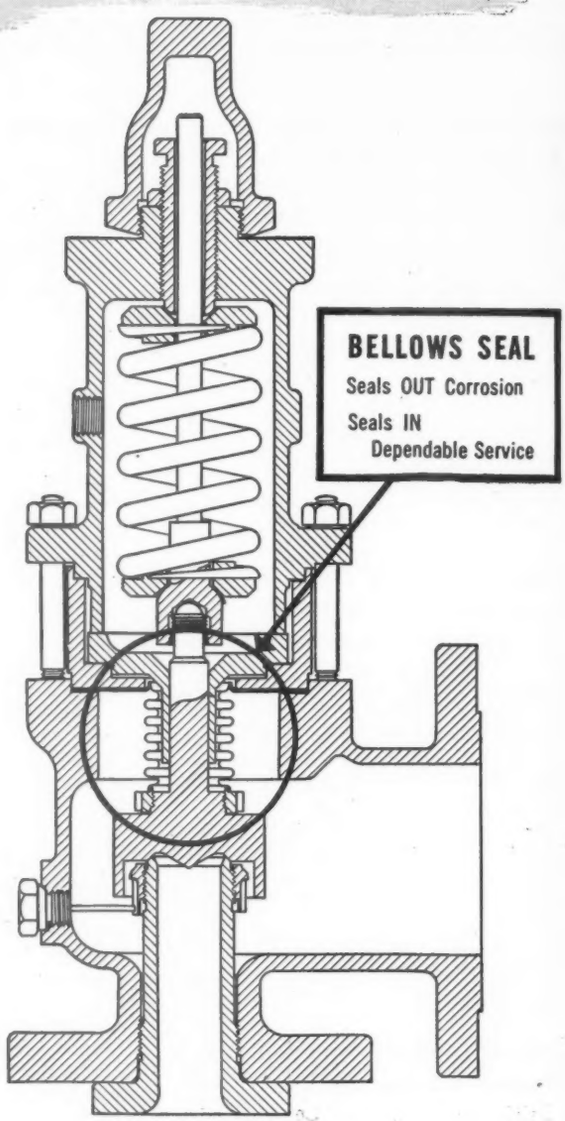

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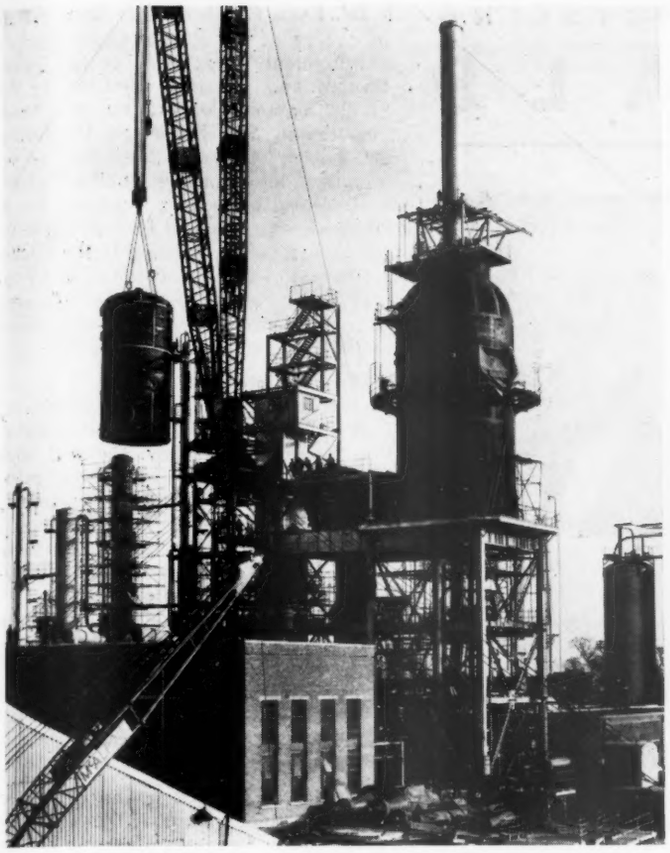
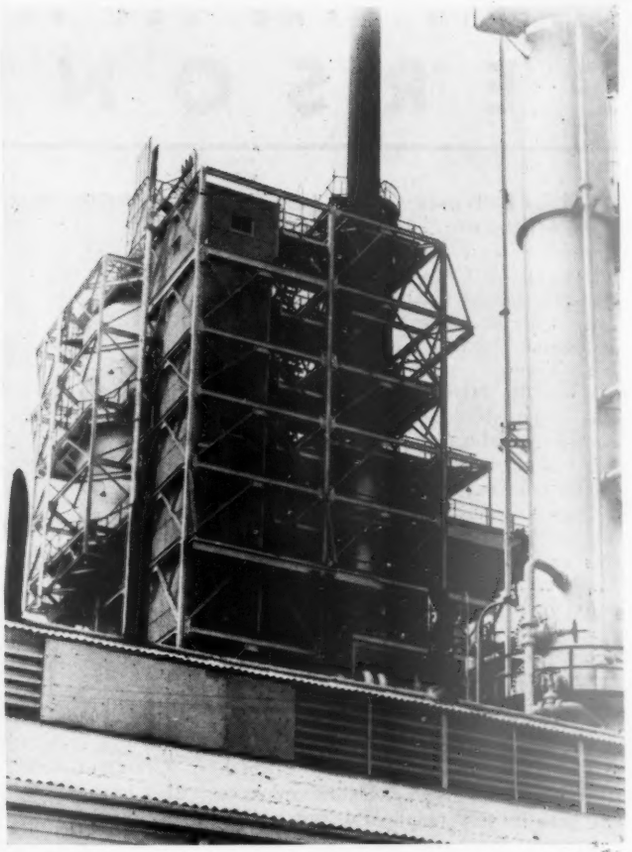


Nearing Completion is the Fluid catalytic cracking unit at the Kent, England, refinery of Anglo-Iranian Oil Company. Kellogg International Corporation is supervising installation of the cracker. Above, reactor top-section is being lifted into place.



Special flue gas snubber installed and operating on cat cracker of Union Oil Company, Wilmington, California, by Burgess-Manning Company. It's 41 ft, 3 in. long, 12 ft, 7 in. in diameter and weighs 66,900 lb. It controls 407,500 lb of flue gas per hour at 575 F.

Imperial to Raise Refinery Capacity at Montreal

A 25 per cent increase in the capacity of Imperial Oil's Montreal East refinery has been announced by general superintendent Charles Scrymgeour. New equipment to be installed includes an atmospheric and vacuum distillation unit.

The new construction will increase capacity by 12,000 bbl to 58,000 bbl a day and will further improve product quality. The refinery will continue to be Canada's second largest, surpassed only by the Imperial plant at Sarnia.

Canada's first catalytic cracking unit, which was installed at Montreal East in 1948, will be enlarged. In the "cat cracker" heavy oils are broken down to yield high-octane gasoline, furnace fuel, and other products.

About $10,000,000 will be spent on construction work which is expected to be finished early in 1954.

Oil Industry Becomes Net Producer of Sulfur

The petroleum industry produced an estimated 20,000 tons more sulfur in 1952 than it used in its own operations and is expected to produce surpluses amounting to over 100,000 tons in 1953 and over 200,000 tons in 1954, according to estimates of the Petroleum Administration for Defense.

Sulfur output from extraction plants in oil and gas fields and in refineries is expected to more than double between 1951 and 1954. As against 1951 output of 230,000 tons, sulfur production within the industry is estimated at 290,000 tons in 1952, 390,000 tons in 1953, and 500,000 tons in 1954.

Sulfur is principally used in the petroleum industry in the form of sulfuric acid for refining oil products. Gross sulfur requirements for fresh acid in 1951, the last year for which complete figures are available, amounted to 585,000 tons. Net requirements, however, totaled only 235,000 tons.

Vickers' Plant Complete

Bruce K. Brown, former deputy adminstrator of the Petroleum Administration for Defense and president of the Pan-Am Southern Corporation of New Orleans, Louisiana, was the principal speaker at a dinner in Wichita, Kansas, recently when the Vickers Petroleum Company of that city dedicated its multi-million dollar refinery additions, featuring a new thermofor catalytic cracking unit.

At the refinery, Jack A. Vickers, Jr., president of the Vickers Petroleum Company presented Robert P. Miller, president of the Southwestern Engineering Company of Los Angeles, constructors of the new thermofor unit, with a plaque in recognition of that company's completion of the job in less time than anticipated and at a lower cost than estimated. Vickers was one of the speakers at the dinner.

Production Begun at World's Largest Ethylene Unit

World's largest ethylene unit has been placed in operation at Houston, Texas, by Gulf Oil Corporation. The plant will produce annually 2½ billion cubic feet of ethylene gas, which is used extensively as a raw material in making chemicals, T. J. Sullivan, Gulf vice president, announced.

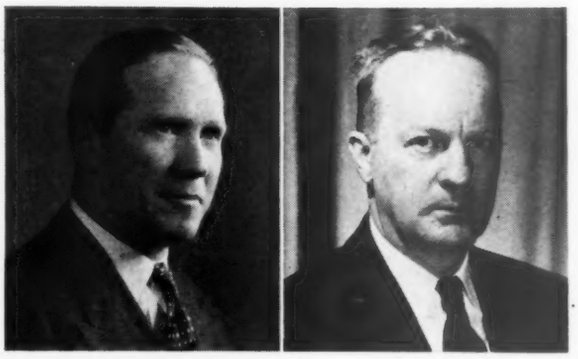
The new unit's entire output has been contracted for by five Texas coast installations, to which the ethylene gas is now flowing through direct-connection pipe lines. These are Koppers Company, Port Arthur; Ethyl Corporation, Houston; E. I. du Pont de Nemours and Company at Orange; Monsanto Chemical Company, Texas City; and Allied Chemical and Dye Corporation, Orange.

AIOC Refineries Hit New Output Mark in 1952

Illustrating Europe's expanded oil refining activities, Anglo-Iranian Oil Company reports that its six Continental refineries processed 25,077,000 more barrels of oil in 1952 than in 1951. Last year's total was 57,253,000 bbl compared with 32,176,000 the year before.

All six refineries contributed to the increase—the two French refineries at Dunkirk and L'Avera, Antwerp refinery and the Porto Marghera refinery near Venice. The company's two German refineries processed 6,434,000 bbl last year, 543,000 bbl more than in 1951.

PERSONALS



George E. Temple

Wilbur E. Kelley

George E. Temple has been appointed vice president and general manager of Catalytic Construction of Canada, Ltd., with headquarters at Sarnia, Ontario, Canada. Temple succeeds **Gordon R. Henderson,** who resigned to become manager of the new 15,000 bbl-per-day refinery of Sun Oil Company also at Sarnia. Prior to joining Catalytic, Temple was associated with the Anglo-Iranian Oil Company, Ltd., for 16 years. He joined Anglo-Iranian in 1935 and was assigned to the company's refinery at Abadan, Iran.

In 1947 he was named assistant works manager in charge of personnel at Abadan. In this position, he developed and reorganized the personnel system which covered the refinery's 15,000 employees and was largely responsible for an enlightened labor-management relationship. He continued as assistant works manager until he left the company in 1952 following nationalization of the properties by the Iranian Government.

Wilbur E. Kelley has been appointed vice president in charge of engineering of the company. Before joining Catalytic Construction, Kelley was manager of the New York operations office of the U. S. Atomic Energy Commission, which position he held from May, 1947.

Kelley attended the Speed Scientific School of the University of Louisville, where he received his BS and CE degrees and Doctor of engineering.

Dr. Elmer H. Schulz has been promoted to director of research and **Dr. Maurice J. Day** to assistant director for program development at Armour Research Foundation of Illinois Institute of Technology. Dr. Schulz has an outstanding record as a scientist and administrator. He will direct the research and development activities of more than 850 scientists and engineers at the Foundation. His former post was manager of the physics and electrical engineering division.

E. D. Powers has been named president of Chemical Construction Corporation. He will remain as vice president and director of the parent firm, American Cyanamid Company. Major General William N. Porter, who had been president of Chemical Construction Corporation since 1947, was elected chairman of the board of directors.

Powers, who has also been elected a director and member of the executive committee of Chemical Construction Corporation, has been with Cyanamid since 1918 where he has served in numerous capacities with several divisions. He was elected vice president in 1950.

General Porter became a major general of the U. S. Army in 1941. He was Chief of the Chemical Warfare Service from 1941 to 1945 when he retired to become associated with American Cyanamid Company.

E. E. Ebner, general superintendent of refineries for Quaker State Oil Refining Corporation, is the new chairman of the Technical Advisory Committee of the Pennsylvania Grade Crude Oil Association. C. E. Streeter of Bradford, president of the association, appointed Ebner to succeed the late MacLean Houston of Warren as committee chairman. **Dr. A. W. Lewis** of Tide Water Associated Oil Company's research and development department, has been acting chairman.

At a meeting of the committee Ebner appointed the following chairmen of subcommittees: **Dr. Lewis,** Armour Research Foundation of Illinois Institute of Technology, steering subcommittee; **F. I. L. Lawrence,** Kendall Refining Company, steering subcommittee of the petroleum refining laboratory, Pennsylvania State College, and **C. W. Cable** of United Refining Company, additive subcommittee.

W. E. Kennel has been promoted to section leader in the chemical products division at Standard Oil Company's Whiting, Indiana, research laboratories. **V. J. O'Brien, Jr.,** and **K. C. Peterson** have been appointed group leaders in the same division.

Dr. Kennel joined Standard in 1948 as a chemical engineer, and was advanced to group leader in 1952. He is a graduate of the University of Illinois, and Massachusetts Institute of Technology.

Dr. O'Brien came to the company in 1950 as a chemical engineer. He is a graduate of the University of Illinois, and holds master's and doctor's degrees from Pennsylvania State College. Peterson joined Standard as a chemical engineer in 1947. He is a graduate of the University of Wisconsin, from which he also received a master's degree.

Dr. Leon C. Glover has been placed in charge of the Pacific Coast product development department of the Julius Hyman and Company division of the Shell Chemical Corporation, with headquarters in San Francisco, California. Dr. Glover, formerly head of the entomology department at Shell's Modesto agricultural laboratory, replaces **Dr. S. H. Benedict,** who will become the company's area representative in the Pacific Northwest. Glover was one of the original staff members of the Modesto agriculture laboratory when it was opened in 1946.

Harold Bottomley, formerly a vice president for Refinery Engineering Company has announced his resignation from the company. He will open offices in the Midco Building in Tulsa, Oklahoma, as a petroleum processing consultant offering the oil industry his services in plant process surveys, economic studies, appraisals and evaluations, and mechanical design.

Bottomley is a graduate of Oklahoma A. & M. College. He has been draftsman and chemist for Shell Petroleum Corporation; chemical engineer and chief research chemist for Kanotex, and chemical engineer and chief research chemist for Cosden.

John H. Wishnick, manager of the Chicago, Illinois, plant of Witco Chemical Company, has been placed in charge of chemical manufacturing at the Chicago and Brooklyn plants. Wishnick graduated from the University of Oklahoma in 1948 and came to Witco as a petroleum engineer for the Continental Carbon Company.

Henry W. Havins has been advanced to the post of division foreman for General Petroleum Corporation's gas department at Ventura, California. Havins, who had been plant foreman at Ventura since 1932, has been with the company's gas department since 1926.

During his company service he has also been foreman at the Tonner, Alamitos, and Sterling absorption plants and the Athens gasoline plant.

Dr. Otto Kay, a specialist in inorganic industrial chemistry, has recently joined the staff of Sam Tour and Company, Inc., a research, development and testing firm in New York City. Dr. Kay was appointed director of the firm's chemical department. Prior to joining the Sam Tour organization, Dr. Kay was a technical consultant in New York City, and previously, was associated with the Armour Research Foundation where he specialized in extraction metallurgy, particularly that of titanium.

T. Wayne Warren has joined Ethyl Corporation as supervisor of research in refinery technology at the Detroit research laboratories. Following two years of service as a naval officer in the Pacific, Warren joined the technical service division of Humble Oil and Refining Company at Baytown, Texas. For 17 months he was on leave of absence from Humble to serve as an aviation fuels specialist for the Petroleum Administration for Defense in Washington.

Through the rocky West Texas area as many as 16 wagon drills were used by the contractor to make shot holes for blasting.

New Crude Oil Line in Operation

Rancho Pipe Line Company system to Gulf Coast area provides new outlet for Permian Basin

FRANK H. LOVE*

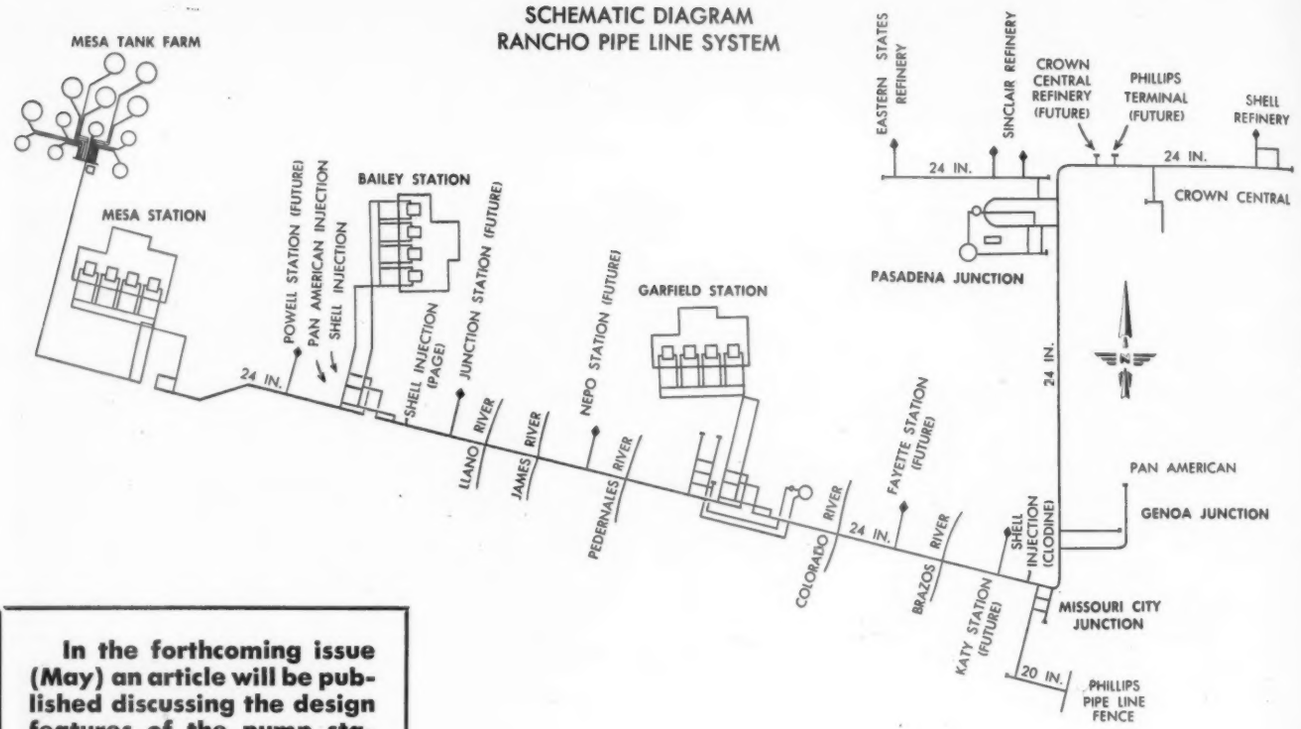
EXCLUSIVE

CRUDE began flowing through the Rancho Pipe Line Company system early in March, marking the completion of a new outlet for Permian Basin oil and an increased supply for refineries in the Gulf Coast area. The line extends approximately 457 miles from McCamey, Texas, to the vicinity of Houston, is constructed of 24-in. pipe, and has three pumping stations in its initial setup.

The system was constructed, and will be operated, by Shell Pipe Line Corporation, but is owned in undivided interest by a group of seven companies. These are Shell Pipe Line Corporation, Sinclair Pipe Line Company, Pan American Pipe Line Company, Crown-

*Editor, Oil and Gas Pipelining.

Welders running finishing welds on Rancho system.



In the forthcoming issue (May) an article will be published discussing the design features of the pump stations on the Rancho Pipe Line Company system.

Rancho Pipe Line Corporation, Nantucket Pipe Line Company, Phillips Pipe Line Company, and Ashland Pipe Line Company.

Initial capacity of the system is 210,000 bbl a day with three stations, and can be increased to 345,000 bbl per day by the addition of five intermediate stations. These capacities are based on 60 SUS viscosity, 0.835 specific gravity crude, and 97 per cent load factor. Under normal conditions the line will be operated at a suction pressure of 25 psi and a discharge pressure of 850 psi.

Almost exactly a year was required to complete the project, but there was a considerable period of inactivity due to the steel strike and resulting inability to obtain line pipe.

The route of the line parallels Shell's existing 10-in. line from McCamey to a point about 20 miles west of Sealy, but from that point east new right-of-way was obtained to avoid laying the line through residential subdivisions and across industrial developments. The crude oil supply originates in the West Texas-New Mexico area and batches are accumulated at new tank farms at McCamey and Eldorado.

The three initial pump stations are Mesa station, approximately 2 miles southeast of McCamey; Bailey station, about 2½ miles south of Eldorado, and Garfield station, approximately 14 miles southeast of Austin.

Near McCamey a project-owned tank farm, called Mesa Tank Farm, has been erected, consisting of six 80,000-bbl and six 122,000-bbl floating roof tanks initially, with space provision for 11 additional tanks. The common suction-fill lines from the tanks to the central valve manifold are of 26 and 30 in. diameter, and the suction line from the central manifold to Mesa station is 30 in.

Missouri City is a take-off point for deliveries to Phillips. Genoa is a take-off point for delivery to Pan American. Pasadena is the operating center for dispatching crude to various termini. At this point one line branches to the west with take-offs for deliveries to the Sinclair refinery, and terminates at the Eastern States Refinery. Another line

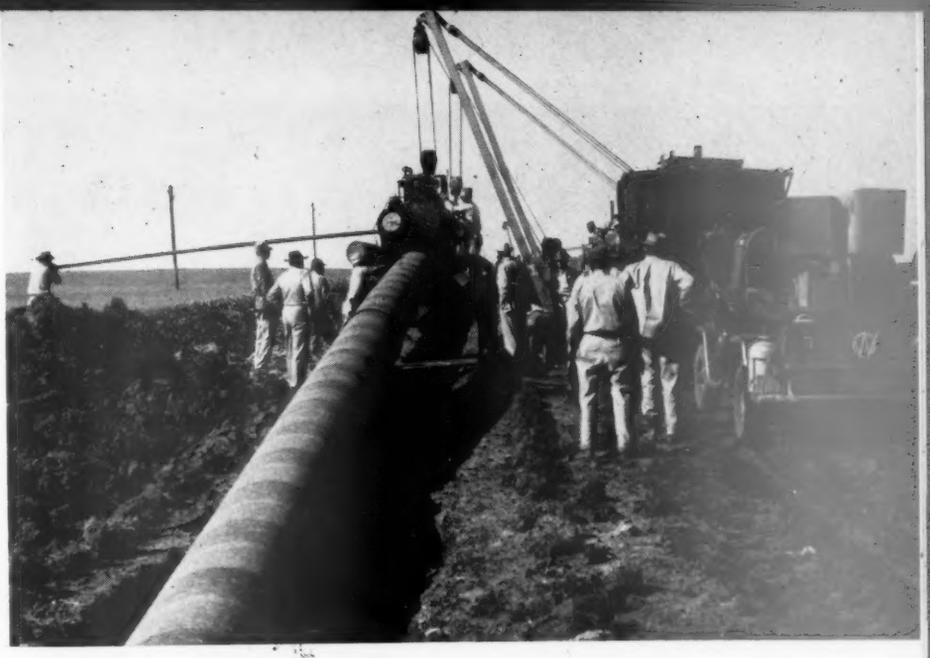
Caved in ditch being cleaned out with a clamshell.

Backfilling with sideboom and dragline.

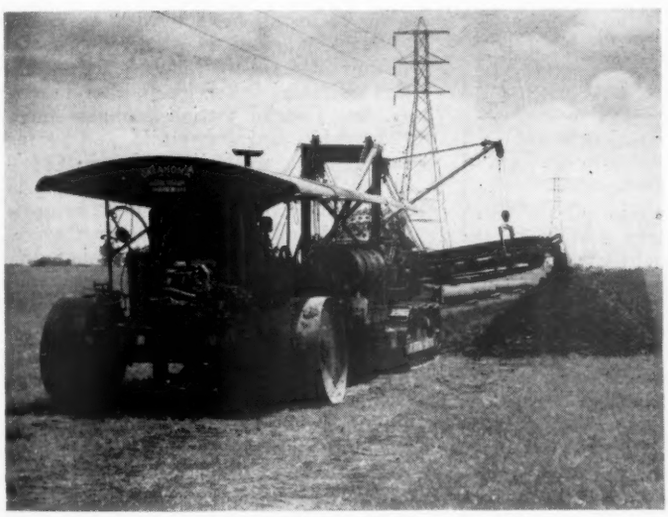
branches to the east with take-off for deliveries to Crown Central tank farm and terminates at Shell's Deer Park refinery.

As mentioned, mainline pipe is 24 in. in diam, with wall thicknesses of 5/16, 11/32, and 3/8 in. River crossing pipe has a wall thickness of ½ in. Of the total, 256.98 miles were laid of 5/16-in. pipe, weighing 79.06 lb per ft and having a yield strength of 52,000 psi. The 11/32-in. wall pipe weighs 86.85 lb per ft and most of it has a yield strength of 52,000 psi; of a total of 134.52 miles, 16.40 miles of pipe have a yield of 46,000 psi. The ⅜-in. wall pipe, of which 66.16 miles were laid, weighs 94.62 lb per ft and has a yield strength of 52,000 psi. The ½-in. wall pipe, that was used in river crossings, weighs 125.49 lb per ft and has a yield of 42,000 psi. In all 2.90 miles of this pipe were installed.

The line was laid in a conventional manner, except in those instances where conditions of terrain necessitated otherwise. The western segment of the line



Coating and wrapping the 24-in. pipe.



A large ditching machine cuts through the level country of Gulf Coast Texas.

Cleaning out ditch with a backhoe.

Making radiographic inspection of a weld.

Lining-up a joint of pipe for the stringer bead.

Digging trench near Columbus, Texas.

is principally through rocky grazing land, requiring continuous blasting to make ditch. Despite this handicap, however, the contractor made exceptionally good progress by employing as many as 16 wagon drills to make shot holes.

In such areas, also, the bottom of the rock ditch was padded with 6 in. of backfill free of hard objects, and a section of 24-in. pipe was dragged along the top of the padding to form a properly shaped supporting surface before the pipe was lowered-in. Coating and wrapping were protected during backfill by a shield made of a half-section of 26-in. pipe from 18 to 20 in. long, which was placed over the 24-in. pipe. After about 10 in. of fill, the shield was pulled ahead and the remainder of the ditch backfilled. The eastern portion of the line presented no such difficulties as it traversed mainly rock free, agricultural areas.

Pipe joints were welded by the manual electric arc method and stove-pipe line-up. Physical tests and radiographic inspection methods were used for welder qualification. All river crossing welds were radiographed. All welds on cross country construction were visually inspected, and about 15 per cent were radiographed.

Cross-country pipe was protected against corrosion by a single coat of enamel, one wrap of glass fiber reinforcing, and one wrap of 6-lb impregnated asbestos felt. Pipe at river crossings, and in casing at railroad and highway crossings, was given additional protection. In such cases, a triple coating of enamel was applied together with three wraps of glass fiber reinforcing. Negative buoyancy of the Colorado and Brazos river crossings were attained by adding a 2½-in. thick gunite sheath. At the Llano, James, and Pedernales rivers and Beaver Creek, the bottom of the rock ditch was leveled with concrete and the ditch filled with concrete after the pipe had been lowered.

Block valves and insulating flanges were installed on both sides of rivers. Through-conduit double-disk gate valves and double-disk parallel seat valves were installed on the main line and at tanks. These are of both the gear and motor-operated types. At the Mesa Tank Farm plug valves were used in small diameter feeder line connections.

Cold-bending a joint of pipe.

Facilities by Other Companies

Other companies participating in this project have installed or have announced plans to install the following facilities:

Pan American constructed Concho station adjacent to Rancho's Bailey station to make deliveries to the Rancho system. Concho station includes three 124,000-bbl tanks, manifold, and pumps for delivery to Bailey station. Crude oil is delivered to Concho storage via Pan American's 16-in. line (approximately 44 miles) from Scurry County, and a 6-in. line from the Hulldale-Susan Peak fields. Pan American also constructed a 28-mile, 16-in. line from Genoa to Texas City and added four new 120,000-bbl floating roof tanks at Texas City.

Shell Pipe Line Corporation has installed tankage and pumps for injecting Hulldale-Susan Peak crude at Bailey station.

Phillips will build a terminal and pump station near Missouri City for receipt of crude from Rancho and for pumping to Sweeny. This installation includes a pump station, two 120,000-bbl floating roof tanks, and a 12-in. line to Sweeny.

Sinclair has supplemented existing tankage at Sinco with three 180,000-bbl tanks.

Crown Central has installed one new 131,000-bbl tank at Pasadena.

Shell has supplemented its existing tankage at Deer Park with four new 116,000-bbl tanks.

Eastern States is receiving into existing tankage at Manchester.

Contractors

The major contractors for laying of the pipe were as follows:

Anderson Brothers Corporation: Installation of Section I of main line, approximately 266 miles from Mesa to a point near Cedar Valley.

Houston Contracting Company: Section II of main line, consisting of approximately 189 miles from Cedar Valley to Houston to termini in the Houston area. A part of this work was subcontracted to Oklahoma Pipe Line Constructors. ★ ★ ★

Pipe Line Flow Calculations

Tables presented expedite solution of problems involving the Weymouth and Panhandle formulae

J. W. J. BERCHER

The complex nature of the accepted gas pipe line flow formulae are such as to make their field use awkward and time consuming. The tables presented with this discussion were prepared to expedite the solution of problems involving the Weymouth and Panhandle formulae. In order to facilitate the construction of tables covering terms in the Weymouth Formulae, it has been put into the following form:

$$Q = 18.06 \times T_o \times 1/P_o \times \sqrt{1/G} \times \sqrt{1/T} \times D^{8/3} \times (P_1^2 - P_2^2)^{1/2} \times \sqrt{1/L}$$

Where:

- Q = standard cu ft per 24 hr at T and P
- T_o = base temperature, deg. absolute
- P_o = base pressure, psia
- G = specific gravity (air = 1)
- T = flowing temperature, deg. absolute
- D = inside diameter of pipe, in.
- P_1 = inlet pressure, psia
- P_2 = outlet pressure, psia
- L = length of line, miles

The Panhandle Formula is usually written:

$$Q = 864.93 \times (520/460 + t)^{0.5394} \times (0.6/G)^{0.4606} \times D^{2.6182} \times P_1^2 - P_2^2)^{0.5394} \times (1/L)^{0.5394} \times E$$

Where:

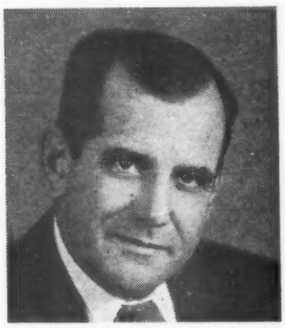
- Q = cubic feet per 24 hr at standard conditions
- t = flowing temperature, °F
- G = specific gravity (air = 1)
- D = inside diameter of pipe, in.
- P_1 = inlet pressure, psia
- P_2 = outlet pressure, psia
- L = length of line, miles
- E = experience factor (sometimes termed "efficiency factor")

In practice certain terms will be fixed by design and/or operating conditions. For convenience these terms may be combined by the computer. As an example, a section of line between main line booster stations that is being checked periodically in order to set up a schedule for internal cleaning, will vary only in the terms $(P_1^2 - P_2^2)$ and E.

The term E, although it is not usually included in the Weymouth Formula, will be desirable in that it will reduce errors arising from variations in the condition of the pipe wall, differences in elevation, temperature changes, entrained liquids, and other deviations from the ideal.

In the case of high pressure lines a compressibility, or fugacity, factor should be included. For use in the Weymouth Formula this factor will be $\sqrt{1/Z}$ and in the Panhandle Formula the value will be $(1/Z)^{0.5394}$. In general no serious error will result if the factor $\sqrt{1/Z}$ is used with the Panhandle Formula. Values taken from the curve of Z vs. $\sqrt{1/Z}$ will be satisfactory for many cases.

In pipe line operation it is often necessary to estimate the storage capacity of lines in gas service. The following formulae were derived for field use. It should be noted that two values are given, one is exact enough for office use whereas the second is rounded off for use in the field.



J. W. J. Bercher is project engineer on the Texas Eastern Transmission Corporation construction program east of Wheelersburg, Ohio. He has had experience in pipe line construction, oil and gas pipe line operation, and his present work. He is a registered engineer in Texas, and is a member of American Institute of Mining and Metallurgical Engineers and the American Society of Mechanical Engineers.

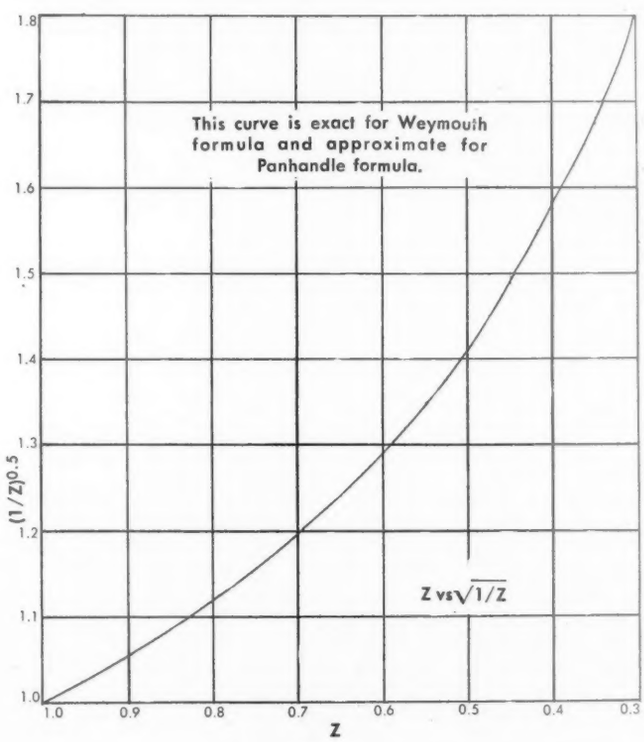


FIG. 1.

EXCLUSIVE

Storage capacity at atmospheric pressure (Opsig):

Cubic feet per ft = $0.00545\ d^2 = 0.005\ d^2$

Cubic feet per 100 ft—$0.5454\ d^2 = 0.5\ d^2$

Cubic feet per 1000 ft = $5.454\ d^2 = 5.5\ d^2$

Cubic feet per mile = $28.797\ d^2 = 28.8\ d^2$

Storage capacity at a line pressure P, when 1 atmos. = 14.7 psia:

Cubic feet per 100 ft = $0.0371\ Pd^2 = 0.0004\ Pd^2$

Cubic feet per ft = $0.000371\ Pd^2 = 0.04\ Pd^2$

Cubic feet per 1000 ft = $0.371\ Pd^2 = 0.4\ Pd^2$

Cubic feet per mile = $1.959\ Pd^2 = 2\ Pd^2$

Where:

d = inside diameter, in.

P = line pressure, psia.

Values of terms in the Weymouth formula

Value of $(P_1^2 - P_2^2)^{1/2}$

	P_2							
P	550	560	570	580	590	600	610	620
560	105.36							
570	149.66	106.30						
580	184.12	151.00	107.24					
590	213.54	185.74	152.32	108.17				
600	239.79	215.40	187.35	153.62	109.09			
610	263.82	241.87	217.26	188.94	154.92	110.00		
620	286.18	266.08	243.93	219.09	190.53	156.20	110.91	
630	307.25	288.62	268.33	245.97	220.91	192.09	157.48	111.80
640	327.26	309.84	291.03	270.56	247.99	222.71	193.65	158.74
650	346.41	330.00	312.41	293.43	272.76	250.00	224.50	195.19
660	364.83	349.29	332.72	314.96	295.80	274.95	251.99	226.27
670	382.62	367.83	352.14	335.41	317.49	298.16	277.13	253.97
680	399.88	385.75	370.81	354.96	338.08	320.00	300.50	279.28
690	416.65	403.11	388.84	373.76	357.77	340.74	322.49	302.82
700	433.01	420.00	406.33	391.92	376.70	360.56	343.37	324.96
710	449.00	436.46	423.32	409.51	394.97	379.61	363.32	345.98
720	464.65	452.55	439.89	426.61	412.67	397.99	382.49	366.06
730	480.00	468.29	456.07	443.28	429.88	415.81	401.00	385.36
740	495.08	483.74	471.91	459.57	446.65	433.13	418.93	403.98
750	509.90	498.90	487.44	475.50	463.03	450.00	436.35	422.02
760	524.50	513.81	502.69	491.12	479.06	466.48	453.32	439.55
770	538.89	528.49	517.69	506.46	494.77	482.60	469.89	456.62
780	553.08	542.95	532.45	521.54	510.20	498.40	486.11	473.29
790	567.10	557.23	546.99	536.38	525.36	513.91	502.00	489.59
800	580.95	571.31	561.34	551.00	540.28	529.15	517.59	505.57

	P_2							
P_1	630	640	650	660	670	680	690	700
640	112.69							
650	160.00	113.58						
660	196.72	161.25	114.46					
670	228.04	198.24	162.48	115.33				
680	255.93	229.78	199.75	163.71	116.19			
690	281.42	257.88	231.52	201.25	164.92	117.05		
700	305.12	283.55	259.81	233.24	202.73	166.13	117.90	
710	327.41	307.41	285.66	261.73	234.95	204.21	167.33	118.74
720	348.57	329.85	309.68	287.75	263.63	236.64	205.67	168.52
730	368.78	351.14	332.26	311.93	289.83	265.52	238.33	207.12
740	388.20	371.48	353.69	334.66	314.17	291.89	267.39	240.00
750	406.94	391.02	374.17	356.23	337.05	316.39	293.94	269.26
760	425.09	409.88	393.83	376.83	358.75	339.41	318.59	295.97
770	442.72	428.14	412.79	396.61	379.47	361.25	341.76	320.78
780	459.89	445.87	431.16	415.69	399.37	382.10	363.73	344.09
790	476.65	463.14	449.00	434.17	418.57	402.12	384.71	366.20
800	493.05	480.00	466.37	452.11	437.15	421.23	404.85	387.30

	P_2							
P_1	710	720	730	740	750	760	770	780
720	119.58							
730	169.71	120.42						
740	208.57	170.88	121.24					
750	241.66	210.00	172.05	122.06				
760	271.11	243.31	211.42	173.21	122.88			
770	297.99	272.95	244.95	212.84	174.36	123.69		
780	322.96	300.00	274.77	246.58	214.24	175.50	124.50	
790	346.41	325.12	301.99	276.59	248.19	215.64	176.64	125.30
800	368.65	348.71	327.61	303.97	278.39	249.80	217.03	177.76

P_1	P_2 790
800	126.10

Values of $1/P_0$

P_0	$1/P_0$	P_0	$1/P_0$	P_0	$1/P_0$
14.525	0.068847	15.400	0.064935	16.525	0.060514
14.650	0.068259	15.525	0.064412	16.650	0.060060
14.730	0.067889	15.650	0.063898	16.775	0.059612
14.775	0.067682	15.775	0.063391	16.900	0.059172
14.900	0.067114	15.900	0.062893	17.025	0.058737
15.025	0.066556	16.025	0.062403	17.150	0.058309
15.150	0.066007	16.275	0.061444	17.275	0.057887
15.275	0.065466	16.400	0.060976	17.400	0.057471

Values of $\sqrt{1/G}$

G	$\sqrt{1/G}$	G	$\sqrt{1/G}$	G	$\sqrt{1/G}$
0.600	1.2910	0.607	1.2835	0.614	1.2762
0.601	1.2899	0.608	1.2825	0.615	1.2752
0.602	1.2888	0.609	1.2814	0.616	1.2741
0.603	1.2878	0.610	1.2804	0.617	1.2731
0.604	1.2867	0.611	1.2793	0.618	1.2721
0.605	1.2857	0.612	1.2782	0.619	1.2710
0.606	1.2846	0.613	1.2772	0.620	1.2700

Values of $\sqrt{1/T}$ for various values of t (T = 460 + t)

t	$\sqrt{1/T}$	t	$\sqrt{1/T}$	t	$\sqrt{1/T}$
40	0.044721	54	0.044108	68	0.043519
41	0.044676	55	0.044065	69	0.043478
42	0.044632	56	0.044023	70	0.043437
43	0.044588	57	0.043980	71	0.043396
44	0.044544	58	0.043938	72	0.043356
45	0.044499	59	0.043895	73	0.043315
46	0.044455	60	0.043853	74	0.043274
47	0.044412	61	0.043811	75	0.043234
48	0.044368	62	0.043769	76	0.043193
49	0.044324	63	0.043727	77	0.043153
50	0.044281	64	0.043685	78	0.043113
51	0.044237	65	0.043644	79	0.043073
52	0.044194	66	0.043602	80	0.043033
53	0.044151	67	0.043561		

Values of $\sqrt{1/L}$

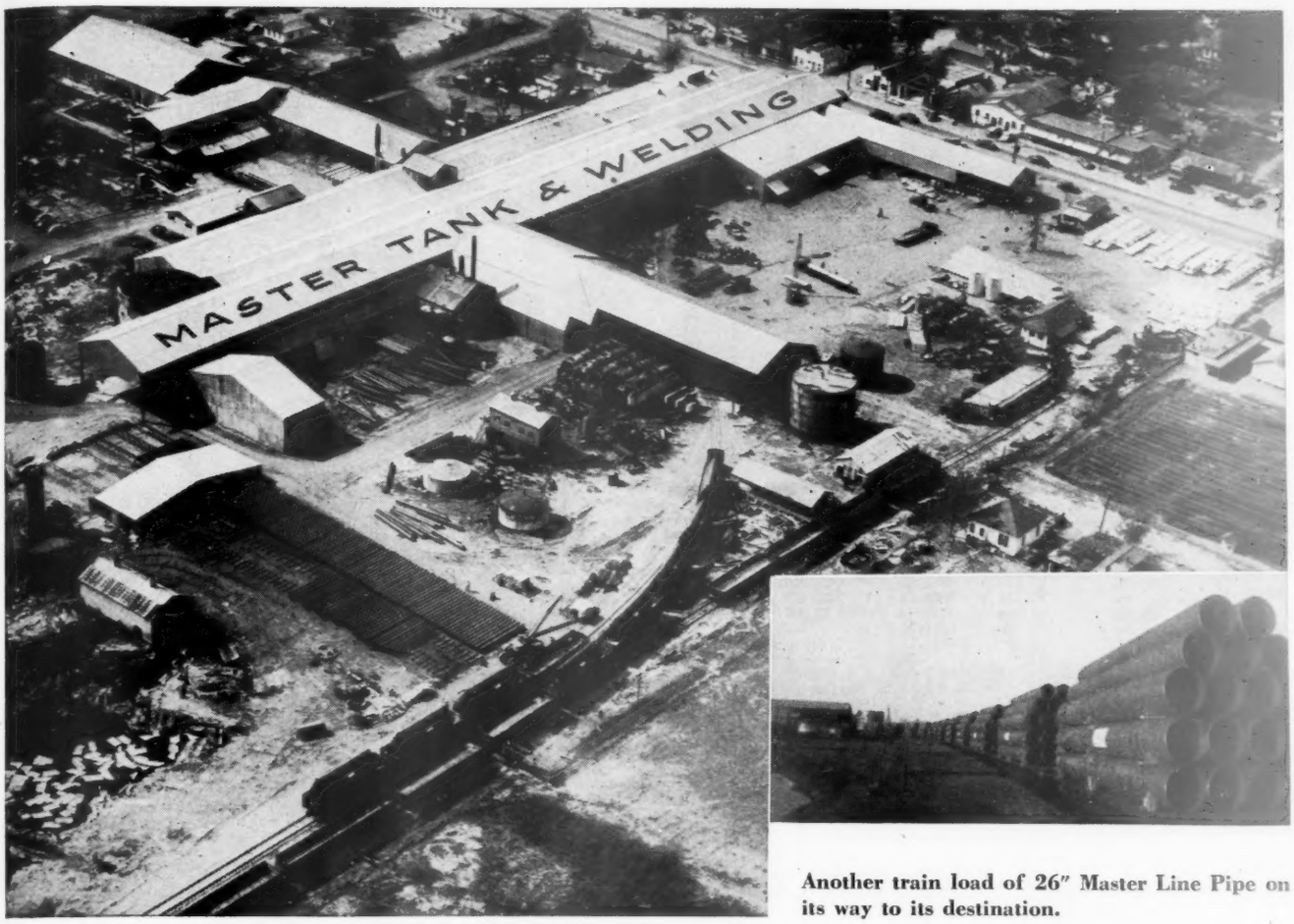
L	√1/L	L	√1/L	L	√1/L	L	√1/L
1	1.00000	41	0.15617	81	0.11111	121	0.090700
2	0.70711	42	0.15430	82	0.11043	122	0.090536
3	0.57735	43	0.15250	83	0.10976	123	0.090167
4	0.50000	44	0.15076	84	0.10911	124	0.089803
5	0.44721	45	0.14907	85	0.10847	125	0.089443
6	0.40825	46	0.14744	86	0.10783	126	0.089087
7	0.37796	47	0.14586	87	0.10721	127	0.088736
8	0.35355	48	0.14434	88	0.10660	128	0.088388
9	0.33333	49	0.14286	89	0.10600	129	0.088045
10	0.31623	50	0.14142	90	0.10540	130	0.087706
11	0.30151	51	0.14002	91	0.10483	131	0.087370
12	0.28868	52	0.13868	92	0.10426	132	0.087039
13	0.27735	53	0.13736	93	0.10370	133	0.086711
14	0.26726	54	0.13608	94	0.10314	134	0.086387
15	0.25820	55	0.13484	95	0.10260	135	0.086066
16	0.25000	56	0.13363	96	0.10206	136	0.085749
17	0.24253	57	0.13245	97	0.10153	137	0.085436
18	0.23570	58	0.13131	98	0.10101	138	0.085126
19	0.22941	59	0.13019	99	0.10050	139	0.084819
20	0.22361	60	0.12910	100	0.10000	140	0.084515
21	0.21822	61	0.12804	101	0.99504	141	0.084215
22	0.21320	62	0.12700	102	0.099015	142	0.083918
23	0.20851	63	0.12599	103	0.098533	143	0.083624
24	0.20412	64	0.12500	104	0.098058	144	0.083333
25	0.20000	65	0.12403	105	0.097590	145	0.083045
26	0.19612	66	0.12309	106	0.097129	146	0.082761
27	0.19245	67	0.12217	107	0.096674	147	0.082479
28	0.18898	68	0.12127	108	0.096225	148	0.082200
29	0.18570	69	0.12039	109	0.095783	149	0.081923
30	0.18257	70	0.11952	110	0.095346	150	0.081650
31	0.17961	71	0.11868	111	0.094916	151	0.081379
32	0.17678	72	0.11785	112	0.094600	152	0.081111
33	0.17408	73	0.11704	113	0.094072	153	0.080845
34	0.17150	74	0.11625	114	0.093659	154	0.080582
35	0.16903	75	0.11547	115	0.093250	155	0.080322
36	0.16667	76	0.11471	116	0.092848	156	0.080064
37	0.16440	77	0.11396	117	0.092557	157	0.079809
38	0.16241	78	0.11323	118	0.092057	158	0.079556
39	0.16013	79	0.11251	119	0.091670	159	0.079305
40	0.15811	80	0.11180	120	0.091287	160	0.079057

Values of $D^{8/3}$ (12 in nominal pipe)

D	$D^{8/3}$	D	$D^{8/3}$	D	$D^{8/3}$
12.344	813.93	12.062	765.28	11.376	654.65
12.312	808.31	12.000	754.84	11.064	607.86
12.274	801.66	11.938	744.48	11.000	598.52
12.250	797.50	11.874	733.88	10.500	528.70
12.192	787.47	11.750	713.63	10.313	503.96
12.150	780.26	11.626	693.72	10.126	479.96
12.090	770.03	11.500	673.85		

Values of $D^{8/3}$

(14 in nominal pipe)		(16 in nominal pipe)		(18 in nominal pipe)	
D	$D^{8/3}$	D	$D^{8/3}$	D	$D^{8/3}$
13.624	1058.89	15.624	1525.76	17.500	2064.47
13.560	1045.68	15.524	1507.14	17.375	2025.38
13.524	1038.29	15.500	1493.68	17.250	1986.76
13.500	1033.38	15.438	1477.80	17.125	1948.60
13.375	1008.07	15.375	1461.77	17.000	1910.90
13.250	983.14	15.312	1445.85	16.874	1873.36
13.188	970.91	15.250	1430.29	16.813	1855.36
13.125	958.60	15.188	1414.84	16.750	1836.88
13.062	946.37	15.124	1399.00	16.625	1800.55
13.000	934.44	15.062	1383.76	16.564	1782.99
12.875	910.67	15.000	1368.62	16.500	1764.67
12.814	899.21	14.938	1353.59	16.375	1729.25
12.750	887.29	14.875	1338.42	16.250	1694.27
12.688	875.83	14.750	1308.63	16.126	1660.01
12.625	864.28	14.688	1294.02	15.688	1542.41
12.500	841.65	14.625	1279.27	15.314	1446.36
12.250	797.50	14.500	1250.32	14.876	1338.66
12.125	775.99	14.314	1208.00	14.625	1279.27
11.876	734.21	14.250	1193.65	14.500	1250.32
11.500	673.85	13.938	1125.23		
11.313	645.03	13.564	1046.50		
11.188	626.19	13.126	958.79		
		13.000	934.44		
		12.876	910.67		



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Values of $D^{8/3}$ — Continued

20 in nominal pipe D	20 in nominal pipe $D^{8/3}$	22 in nominal pipe D	22 in nominal pipe $D^{8/3}$	24 in nominal pipe D	24 in nominal pipe $D^{8/3}$
19.500	2755.09	21.656	3644.07	23.500	4531.34
19.374	2707.87	21.628	3631.51	23.376	4467.86
19.250	2661.90	21.562	3602.04	23.250	4403.93
19.124	2615.69	21.500	3574.49	23.125	4341.07
19.000	2570.70	21.438	3547.06	23.000	4278.78
18.875	2525.85	21.398	3529.44	22.876	4217.54
18.814	2504.14	21.375	3519.33	22.750	4155.87
18.750	2481.59	21.320	3495.24	22.676	4095.74
18.625	2437.62	21.312	3491.76	22.500	4035.20
18.500	2394.24	21.250	3464.73	22.125	3858.34
18.376	2351.68	21.200	3443.02	21.938	3771.99
18.250	2308.93	21.188	3437.83	21.564	3602.93
18.188	2288.07	21.125	3410.64	21.000	3357.08
17.938	2205.16	21.062	3383.58	20.500	3148.14
17.500	2064.47	21.000	3357.08	19.876	2899.04
17.438	2045.03	20.875	3304.06	19.625	2802.43
17.000	1907.90	20.750	3251.56	19.376	2708.61
16.500	1764.67	20.675	3220.32		
16.313	1711.84	20.500	3148.14		
16.126	1660.01				

26 in nominal pipe D	26 in nominal pipe $D^{8/3}$	28 in nominal pipe D	28 in nominal pipe $D^{8/3}$	30 in nominal pipe D	30 in nominal pipe $D^{8/3}$
25.624	5707.41	27.624	6973.95	29.500	8309.49
25.562	5670.65	27.562	6932.29	29.438	8263.00
25.500	5634.05	27.500	6890.78	29.376	8216.68
25.438	5597.60	27.438	6849.43	29.250	8123.03
25.376	5561.29	27.376	6808.24	29.123	8029.31
25.250	5487.95	27.250	6724.99	29.000	7939.20
25.123	5414.64	27.123	6641.74		
25.000	5344.25	27.000	6561.72	36 in nominal pipe	
				35.500	13614.26
				35.438	13550.94
				35.376	13487.81
				35.250	13360.08
				35.123	13232.11
				35.000	13108.89

Values of terms in the Panhandle formula

Values of the term $(1/L)^{0.5394}$

L	$(1/L)^{0.5394}$	L	$(1/L)^{0.5394}$	L	$(1/L)^{0.5394}$
1	1.00000	41	0.13492	81	0.09345
2	0.68806	42	0.13317	82	0.09283
3	0.55289	43	0.13149	83	0.09222
4	0.47342	44	0.12987	84	0.09163
5	0.41974	45	0.12831	85	0.09105
6	0.38042	46	0.12680	86	0.09048
7	0.35007	47	0.12533	87	0.08991
8	0.32574	48	0.12392	88	0.08936
9	0.30569	49	0.12255	89	0.08882
10	0.28880	50	0.12122	90	0.08828
11	0.27433	51	0.11993	91	0.08776
12	0.26175	52	0.11868	92	0.08724
13	0.25069	53	0.11747	93	0.08674
14	0.24087	54	0.11629	94	0.08624
15	0.23207	55	0.11515	95	0.08575
16	0.22413	56	0.11403	96	0.08526
17	0.21692	57	0.11295	97	0.08479
18	0.21033	58	0.11189	98	0.08432
19	0.20429	59	0.11087	99	0.08386
20	0.19871	60	0.10987	100	0.08341
21	0.19355	61	0.10889	101	0.08296
22	0.18875	62	0.10794	102	0.08252
23	0.18428	63	0.10701	103	0.08209
24	0.18010	64	0.10611	104	0.08166
25	0.17618	65	0.10522	105	0.08124
26	0.17249	66	0.10460	106	0.08083
27	0.16862	67	0.10352	107	0.08042
28	0.16573	68	0.10269	108	0.08002
29	0.16262	69	0.10189	109	0.07962
30	0.15968	70	0.10110	110	0.07923
31	0.15724	71	0.1003	111	0.07884
32	0.15421	72	0.09958	112	0.07846
33	0.15167	73	0.09884	113	0.07808
34	0.14925	74	0.09812	114	0.07772
35	0.14694	75	0.09741	115	0.07735
36	0.14472	76	0.09671	116	0.07699
37	0.14260	77	0.09603	117	0.07663
38	0.14056	78	0.09537	118	0.07628
39	0.13860	79	0.09472	119	0.07594
40	0.13672	80	0.09408	120	0.07559

G	$(0.6/G)^{0.4606}$	G	$(0.6/G)^{0.4606}$	t	$(520/460+t)^{0.5394}$	t	$(520/460+t)^{0.5394}$
0.600	1.0000	0.616	0.98795	45	1.0159	61	0.099896
0.601	0.99923	0.617	0.98721	46	1.0148	72	0.99793
0.602	0.99847	0.618	0.98648	47	1.0138	63	0.99690
0.603	0.99771	0.619	0.98574	48	1.0127	64	0.99588
0.604	0.99694	0.620	0.98501	49	1.0116	65	0.99485
0.605	0.99618	0.621	0.98428	50	1.0105	66	0.99383
0.606	0.99543	0.622	0.98355	51	1.0095	67	0.99280
0.607	0.99467	0.623	0.98282	52	1.0084	68	0.99180
0.608	0.99392	0.624	0.98210	53	1.0072	69	0.99079
0.609	0.99317	0.625	0.98137	54	1.0063	70	0.98978
0.610	0.99242	0.626	0.98065	55	1.0052	71	0.98877
0.611	0.99167	0.627	0.97993	56	1.0042	72	0.98777
0.612	0.99092	0.628	0.97921	57	1.0031	73	0.98677
0.613	0.99018	0.629	0.97849	58	1.0021	74	0.98577
0.614	0.98943	0.630	0.97778	59	1.0010	75	0.98478
0.615	0.98869			60	1.0000		

Values of the term $d^{2.6182}$

Nominal pipe size,	Schedule number	Wall thickness, in 0.203	Inside diameter, in d	$d^{2.6182}$
12	..	0.203	12.344	720.53
	..	0.219	12.312	715.65
	..	0.238	12.274	709.88
	20	0.250	12.250	706.25
	..	0.279	12.192	697.53
	..	0.300	12.150	691.25
	30	0.330	12.090	682.35
	..	0.344	12.062	678.22
	..	0.375	12.000	669.13
	40	0.406	11.938	660.12
	..	0.438	11.874	650.89
	..	0.500	11.750	633.25
	60	0.562	11.626	615.90
	..	0.625	11.500	598.58
	80	0.687	11.376	581.83
	100	0.843	11.064	540.97
	..	0.875	11.000	532.81
	120	1.000	10.750	501.69
	140	1.125	10.500	471.71
	..	1.219	10.313	450.03
	160	1.312	10.126	428.98
14	..	0.188	13.624	932.90
	..	0.220	13.530	921.47
	..	0.238	13.524	915.08
	10	0.250	13.500	910.84
	20	0.312	13.375	888.92
	30	0.375	13.250	867.38
	..	0.406	13.188	856.75
	40	0.437	13.125	846.07
	..	0.469	13.062	835.48
	..	0.500	13.000	825.14
		0.563	12.875	804.53
	60	0.593	12.814	794.58
	..	0.625	12.750	784.24
		0.688	12.625	764.26
	..	0.656	12.688	774.29
	80	0.750	12.500	744.61
		0.875	12.250	706.25
	100	0.937	12.125	687.54
	120	1.602	11.876	651.18
	140	1.250	11.500	598.58
	..	1.344	11.313	573.43
	160	1.406	11.188	556.99
16	..	0.188	15.624	1335.32
	..	0.238	15.524	1313.06
	10	0.250	15.500	1307.75
	..	0.281	15.438	1294.10
	20	0.312	15.375	1280.32
	..	0.344	15.312	1266.63
	30	0.375	15.250	1253.25
	..	0.406	15.188	1239.95
	..	0.438	15.124	1226.32
	..	0.469	15.062	1213.20
	40	0.500	15.000	1200.17
	..	0.531	14.938	1187.22
		0.563	14.875	1299.16
		0.625	14.750	1148.50
	60	0.656	14.688	1135.90
	..	0.687	14.625	1123.19
	..	0.750	14.500	1098.23
	80	0.843	14.314	1061.73
		0.825	14.250	1049.34
	100	1.031	13.938	990.25
	120	1.218	13.564	922.18
	140	1.437	13.126	846.24
	..	1.500	13.000	825.14
	60	1.562	12.876	804.69
18	10	0.250	17.500	1796.89
	20	0.312	17.375	1763.48
	..	0.375	17.250	1730.46
	30	0.437	17.125	1697.82
	..	0.500	17.000	1665.56
	40	0.563	16.874	1633.44
	..	0.594	16.813	1618.02
	..	0.625	16.750	1602.20
		0.688	16.625	1571.08
	60	0.718	16.564	1556.03
	..	0.750	16.500	1540.34
	..	0.812	16.375	1509.97
		0.875	16.250	1479.98
	80	0.937	16.126	1450.60
	100	1.156	15.688	1349.69
	120	1.343	15.314	1267.06
	140	1.562	14.876	1174.37
	..	1.687	14.625	1123.19
	160	1.750	14.500	1098.23
20	10	0.250	19.500	2385.44
	..	0.313	19.374	2345.30
	20	0.375	19.250	2306.20
	..	0.438	19.124	2266.88
	30	0.500	19.000	2228.60
	..	0.562	18.875	2190.42
	40	0.593	18.814	2171.93
	..	0.625	18.750	2152.64
		0.688	18.625	2115.27
		0.750	18.500	2078.30
	60	0.812	18.376	2042.03
	..	0.875	18.250	2005.57
	..	0.906	18.188	1987.78
	80	1.031	17.938	1917.04
	100	1.250	17.500	1796.89
	..	1.281	17.438	1780.27
	120	1.500	17.000	1665.56
	140	1.750	16.500	1540.34
	..	1.844	16.313	1495.05
	160	1.937	16.126	1450.60
22		0.177	21.656	3139.14
		0.186	21.628	3128.53
		0.219	21.562	3103.59
		0.250	21.500	3080.28
		0.281	21.438	3057.08

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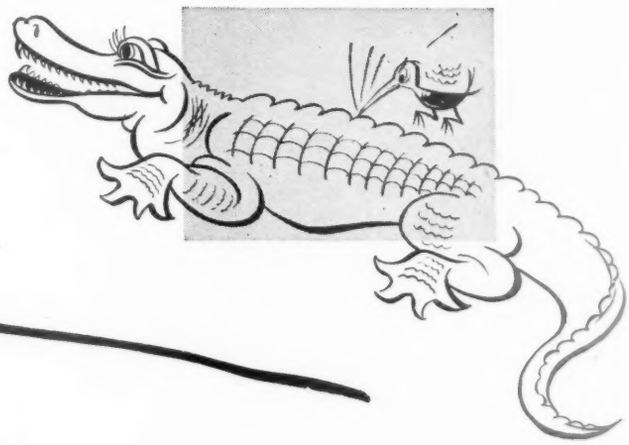

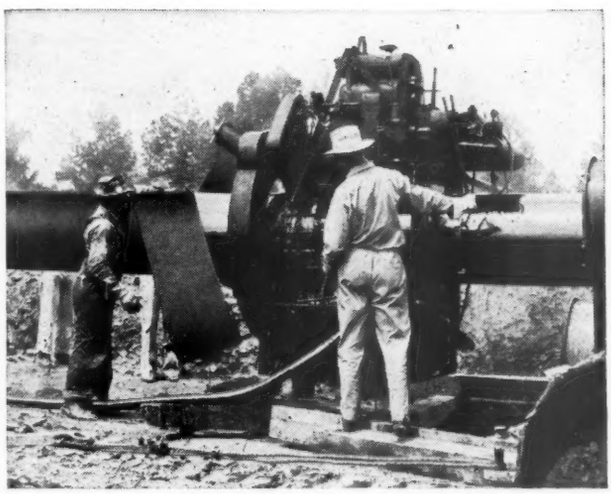

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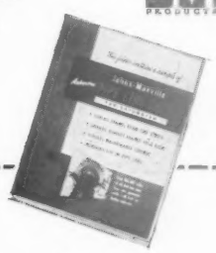

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Values of the term $d^{2.6182}$

Nominal pipe size,	Schedule number	Wall thickness, in.—0.203	Inside diameter, in. d	$d^{2.6182}$
22	..	0.301	21.398	3042.17
	..	0.318	21.375	3033.61
	..	0.340	21.320	3013.22
	..	0.344	21.312	3010.26
	..	0.375	21.250	2987.38
	..	0.400	21.200	2969.02
	..	0.406	21.188	2964.62
	..	0.438	21.125	2941.59
	..	0.469	21.062	2918.68
	..	0.500	21.000	2986.24
	..	0.563	20.875	2851.32
	..	0.625	20.750	2806.83
	..	0.663	20.675	2780.33
	..	0.750	20.500	2719.11
24	10	0.250	23.500	3888.03
	..	0.312	23.376	3834.55
	20	0.375	23.250	3780.67
	..	0.437	23.125	3727.68
	..	0.500	23.000	3675.16
	30	0.562	22.876	3623.51
	..	0.625	22.750	3571.48
	40	0.687	22.626	3520.74
	..	0.750	22.500	3469.64
	60	0.937	22.125	3320.27
	..	1.031	21.938	3247.30
	80	1.218	21.564	3104.35
	100	1.500	21.000	2896.24
	120	1.750	20.500	2719.16
	140	2.062	19.876	2507.75
	..	2.187	19.625	2425.68
	160	2.312	19.376	2345.93

Nom. pipe size,	Wall thickness, in.–0.203	Inside diameter, in. d	$d^{2.5182}$	Nom. pipe size	Wall thickness, in.–0.203	Inside diameter, in. d	$d^{2.5182}$
26	0.188	25.624	4876.62	28	0.188	27.624	5937.13
	0.219	25.562	4845.79		0.219	27.562	5902.30
	0.250	25.500	4815.08		0.250	27.500	5867.60
	0.281	25.438	4784.49		0.281	27.438	5833.03
	0.312	25.376	4754.02		0.312	27.376	5798.59
	0.375	25.250	4692.46		0.375	27.250	5728.97
	0.438	25.123	4630.92		0.438	27.123	5659.33
	0.500	25.000	4571.79		0.500	27.000	5592.38
30	0.250	29.500	7051.60	36	0.250	35.500	11450.07
	0.281	29.438	7012.87		0.281	35.438	11397.78
	0.312	29.376	6974.27		0.312	35.376	11345.64
	0.375	29.250	6896.22		0.375	35.250	11240.15
	0.438	29.123	6818.10		0.438	35.123	11134.43
	0.500	29.000	6742.96		0.500	35.000	11032.63

$(P_1^2 - P_2^2)^{0.5394}$

P_1	P_2 550	555	560	565	570	575	580	585	590
555	104.38								
560	152.07	104.89							
565	189.71	152.81	105.39						
570	222.09	190.62	153.54	105.90					
575	251.10	223.15	191.53	154.28	106.40				
580	277.71	252.30	224.22	192.44	155.00	106.90			
585	302.51	279.03	253.49	225.28	193.35	155.73	107.40		
590	325.87	303.94	280.35	254.69	226.33	194.25	156.45	107.89	
595	348.07	327.41	305.37	281.66	255.87	227.38	195.15	157.17	108.39
600	369.29	349.70	328.94	306.79	282.97	257.06	228.43	196.04	157.89
605	389.68	371.02	351.33	330.47	308.21	284.27	258.23	229.47	196.93
610	409.36	391.50	372.74	352.96	331.99	309.62	285.57	259.41	230.51
615	428.41	411.26	393.31	374.45	354.57	333.52	311.03	286.86	260.58
620	446.92	430.39	413.15	395.11	376.16	356.18	335.01	312.43	288.15
625	464.93	448.97	432.36	415.04	396.90	377.86	357.79	336.52	313.83
630	482.50	467.06	452.02	434.33	416.91	398.69	379.56	359.39	338.01
635	499.68	484.70	469.18	453.06	436.28	418.78	400.47	381.25	360.91
640	516.50	501.95	486.90	471.30	455.09	438.23	420.65	402.25	382.93
645	532.99	518.83	504.21	489.08	473.40	457.12	440.18	422.50	404.01
650	549.17	535.39	521.16	507.09	491.26	475.50	459.14	442.11	424.35
655	565.09	551.64	537.78	523.48	508.71	493.43	477.59	461.14	444.04
660	580.74	567.61	554.09	540.16	525.79	510.94	495.59	479.67	463.15
665	596.16	583.32	570.12	556.54	542.54	528.09	513.17	497.74	481.74
670	611.35	598.80	585.90	572.63	558.97	544.90	530.39	515.39	499.88
675	626.35	614.05	601.43	588.46	575.13	561.40	547.26	532.67	517.60
680	641.14	629.10	616.74	604.05	591.02	577.61	563.82	549.61	534.95
685	657.88	643.95	631.84	619.42	606.66	593.66	580.09	566.23	551.95
690	670.21	660.73	646.75	634.57	622.09	609.27	596.10	582.56	568.63
695	684.50	673.12	663.57	649.53	637.30	624.74	611.86	598.63	584.94
700	698.65	687.46	676.02	664.31	652.31	640.01	627.39	614.44	601.15
705	712.65	701.65	690.41	678.91	667.14	655.07	642.71	630.03	617.02
710	726.51	715.70	704.65	693.35	681.79	669.95	657.83	645.40	632.66
715	740.25	729.62	718.75	707.64	696.28	684.66	672.76	660.58	648.09
720	753.87	743.40	732.71	721.78	710.62	699.20	687.52	675.56	663.31
725	767.37	757.07	746.54	735.79	724.81	713.58	702.11	690.36	678.35
730	780.77	770.61	760.85	749.67	738.86	727.82	716.54	705.00	693.20
735	794.06	784.05	773.84	763.42	752.79	741.92	730.83	719.48	707.89
740	807.26	797.39	787.33	777.06	766.58	755.89	744.97	733.82	722.42
745	820.26	810.63	800.71	790.59	780.27	769.74	758.99	748.01	736.08
750	833.37	823.77	813.98	804.01	793.84	783.46	772.88	762.07	751.04
755	846.29	836.82	827.17	817.33	807.30	797.08	786.65	776.01	765.14
760	859.13	849.78	840.26	830.55	820.66	810.58	800.30	789.82	779.12
765	871.90	862.67	853.26	843.69	833.93	823.99	813.85	803.52	792.98
770	884.59	875.47	866.18	856.73	847.10	837.29	827.30	817.11	806.72
775	897.20	888.20	879.03	869.69	860.19	850.51	840.65	830.60	820.36
780	909.75	900.85	891.79	882.57	873.19	863.63	853.90	843.99	833.89
785	922.23	913.43	904.48	895.37	886.11	876.67	867.06	857.28	847.32
790	934.64	925.95	917.10	908.10	898.95	889.63	880.14	870.48	860.65
795	947.00	938.40	929.66	920.76	911.71	902.51	893.14	883.60	873.89
800	959.29	950.79	942.14	933.35	924.41	915.31	906.05	896.63	887.05

P_1	P_2 595	600	605	610	615	620	625	630	635
600	108.88								
605	158.60	109.37							
610	197.82	159.31	109.86						
615	231.54	198.70	160.02	110.35					
620	261.74	232.57	199.58	160.73	110.83				
625	289.43	262.90	233.60	200.46	161.43	111.32			

P_1	P_2 595	600	605	610	615	620	625	630	635
630	315.22	290.71	264.05	234.62	201.33	162.13	111.80		
635	339.50	316.60	291.98	265.21	235.64	202.21	162.83	112.28	
640	362.57	340.99	317.98	293.25	266.35	236.65	203.07	163.53	112.76
645	384.61	364.15	342.47	319.36	294.51	267.50	237.67	203.94	164.22
650	405.78	386.28	365.72	343.95	320.73	295.77	268.63	238.67	204.80
655	426.19	407.53	387.94	367.29	345.42	322.09	297.02	269.77	239.68
660	445.96	428.03	409.28	389.60	368.85	346.88	323.45	298.27	270.90
665	465.14	447.87	429.86	411.02	391.25	370.41	348.34	324.81	299.52
670	483.81	467.13	449.78	431.68	412.76	392.89	371.96	349.79	326.16
675	502.02	485.87	469.11	451.68	433.50	414.49	394.54	373.51	351.24
680	519.80	504.15	487.92	471.08	453.57	435.31	416.21	396.17	375.04
685	537.21	522.00	506.27	489.97	473.05	455.46	437.11	417.93	397.80
690	554.28	539.47	524.19	508.38	492.00	475.01	457.33	438.91	419.64
695	571.02	556.60	541.73	526.37	510.49	494.03	476.96	459.21	440.70
700	584.47	573.40	558.91	543.97	528.54	512.58	496.06	478.91	461.07
705	603.65	589.92	575.78	561.22	564.21	530.70	514.67	498.07	480.85
710	619.58	606.15	592.35	578.15	563.52	548.43	532.86	516.76	500.08
715	635.28	622.14	608.65	594.78	580.51	565.81	550.65	535.01	518.83
720	650.76	637.89	624.69	611.13	597.19	582.86	568.09	552.87	537.15
725	666.04	653.43	640.49	627.23	613.60	599.60	585.20	570.36	555.07
730	681.12	668.75	656.08	643.09	629.76	616.07	602.00	587.53	572.63
735	696.03	683.89	671.46	658.73	645.67	632.28	618.53	604.39	589.86
740	710.76	698.85	686.65	674.16	661.37	648.25	634.79	620.98	606.78
745	725.34	713.63	701.65	689.40	676.85	663.99	650.81	637.30	623.42
750	739.77	728.26	716.49	704.45	692.14	679.53	666.61	653.37	639.79
755	754.06	742.73	731.16	719.34	707.24	694.87	682.20	669.22	655.92
760	768.21	757.07	745.69	734.06	722.17	710.02	697.59	684.86	671.83
765	782.23	771.26	760.06	748.63	736.94	725.00	712.79	700.30	687.52
770	796.13	785.33	774.30	763.05	751.56	739.82	727.82	715.55	703.00
775	809.92	799.27	788.41	777.34	766.03	754.48	742.69	730.63	718.31
780	823.59	813.10	802.40	791.49	780.36	769.00	757.39	745.54	733.43
785	837.16	826.82	816.27	805.52	794.56	783.37	771.95	760.30	748.39
790	850.63	840.43	830.03	819.44	808.63	797.61	786.37	774.90	763.19
795	864.01	853.94	843.69	833.24	822.59	811.73	800.66	789.36	777.84
800	877.29	867.36	857.24	846.93	836.43	825.73	814.82	803.70	792.35

P_1	P_2 640	645	650	655	660	665	670	675	680
645	113.23								
650	164.91	113.71							
655	205.66	165.60	114.18						
660	240.68	206.51	166.29	114.65					
665	272.03	241.68	207.36	166.97	115.12				
670	300.76	273.15	242.67	208.21	167.65	115.58			
675	327.51	301.99	274.27	243.66	209.06	168.33	116.05		
680	352.69	328.85	303.22	275.38	244.64	209.90	169.00	116.52	
685	376.59	354.13	330.18	304.45	276.49	245.63	210.74	169.68	116.98
690	399.42	378.12	355.56	331.52	305.68	277.60	246.61	211.58	170.35
695	421.34	401.04	379.64	356.99	332.84	306.90	278.70	247.58	212.41
700	442.48	423.04	402.65	381.16	358.41	334.16	308.11	279.80	248.56
705	462.93	444.26	424.74	404.26	382.68	359.83	335.48	309.32	280.90
710	482.78	464.79	446.03	426.42	405.86	384.19	361.25	336.80	310.53
715	502.08	484.70	466.63	447.80	428.11	407.25	385.69	362.65	338.11
720	520.90	504.08	486.62	468.48	449.56	429.78	409.04	387.19	364.06
725	539.29	522.97	506.07	488.54	470.31	451.31	431.45	410.63	388.69
730	557.27	541.41	525.02	508.05	490.44	472.14	453.06	433.12	412.21
735	574.89	559.46	543.53	527.07	510.02	492.34	473.96	454.80	434.78
740	592.18	577.14	561.64	545.65	529.11	511.99	494.24	475.78	456.54
745	609.15	594.49	579.39	563.82	547.75	531.15	513.96	496.12	477.59
750	625.85	611.52	596.79	581.62	565.99	549.85	533.18	515.91	498.01
755	642.28	628.27	613.88	599.09	583.85	568.15	551.95	535.20	517.86
760	658.46	644.76	630.69	616.24	601.37	586.07	570.30	554.03	537.21
765	674.42	661.00	647.23	633.10	618.58	603.65	588.29	572.45	556.11
77	690.16	677.00	663.52	649.69	635.50	620.92	605.93	590.50	574.59
775	705.70	692.80	679.58	666.04	652.15	637.89	623.25	608.19	592.70
780	721.05	708.39	695.42	682.15	668.55	654.60	640.28	625.57	610.45
785	636.22	723.79	711.06	698.04	684.71	671.05	657.03	642.66	627.89
790	751.23	739.01	726.51	713.73	700.65	687.26	673.54	659.47	645.03
795	766.07	754.06	741.78	729.23	716.39	703.26	689.80	676.02	661.89
800	780.77	768.95	756.88	744.54	731.94	719.04	705.85	692.34	678.50

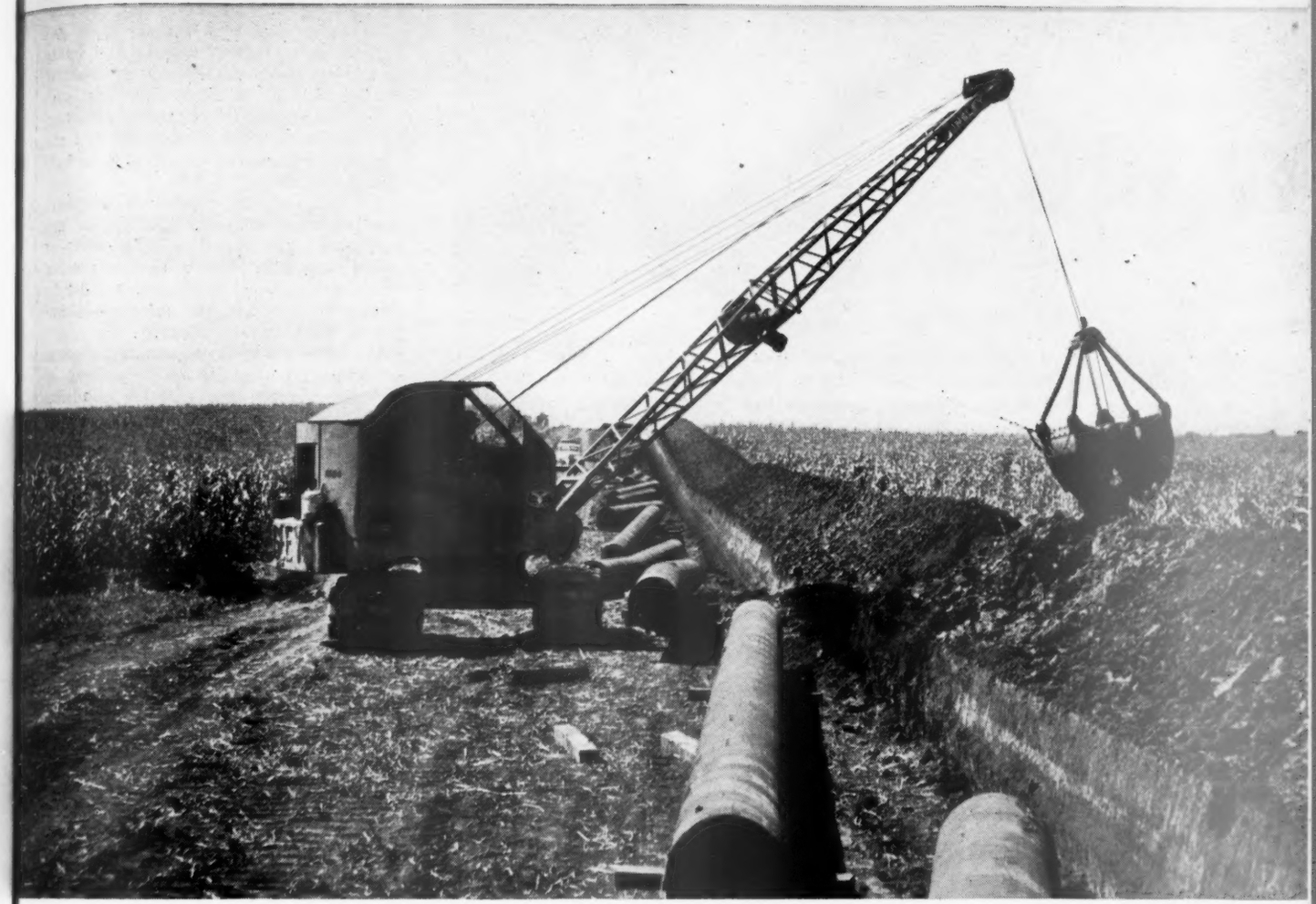
P	P_2 685	690	695	700	705	710	715	720	725
690	117.44								
695	171.02	117.90							
700	213.25	171.69	118.36						
705	249.53	214.08	172.35	118.82					
710	281.99	250.49	214.90	173.02	119.27				
715	311.73	283.08	251.46	215.73	173.67	119.73			
720	339.41	312.93	284.16	252.42	216.55	174.34	120.18		
725	365.46	340.71	314.13	285.24	253.38	217.37	174.99	120.63	
730	390.18	366.86	342.01	315.32	286.32	254.33	218.18	175.65	121.08
735	413.78	391.66	368.25	343.30	316.50	287.40	255.28	218.99	176.30
740	436.43	415.35	393.14	369.63	344.59	317.69	288.47	256.23	219.80
745	458.27	438.08	416.91	394.62	371.02	345.87	318.87	289.54	257.17
750	479.39	460.00	439.73	418.47	396.09	372.39	347.15	320.04	290.60
755	499.88	481.19	461.72	441.37	420.03	397.55	373.77	348.43	321.22
760	519.81	501.74	482.99	463.43	443.00	421.58	399.02	375.14	349.70
765	539.22	521.74	503.61	484.77	465.14	444.63	423.12	400.47	376.50
770	558.18	541.23	523.67	505.47	486.55	466.85	446.25	424.66	401.92
775	576.73	560.35	543.22	525.60	507.32	488.33	468.55	447.87	426.19
780	594.89	578.85	562.31	545.21	527.52	509.17	490.10	470.24	449.48
785	612.70	597.08	580.98	564.36	547.20	529.43	511.01	491.87	471.93
790	630.20	614.95	599.26	583.09	566.41	549.17	531.34	512.84	493.63
795	647.39	632.50	617.19	601.43	585.20	568.45	551.15	533.24	514.67
800	664.31	649.75	634.79	619.42	603.60	587.30	570.48	553.11	535.14

P	P_2 730	735	740	745	750	755	760	765	770
735	121.53								
740	176.95	121.98							
745	220.61	177.60	122.42						
750	258.12	221.42	178.24	122.86					
755	291.66	259.06	222.22	178.89	123.31				
760	322.39	292.72	259.99	223.02	179.53	123.75			
765	350.97	323.55	293.77	260.92	223.82	180.17	124.19		
770	377.86	352.24	324.71	294.82	261.86	224.62	180.81	124.63	
775	403.37	379.22	353.50	325.87	295.87	262.78	225.41	181.45	125.06
780	427.73	404.82	380.57	354.75	327.03	296.92	263.71	226.20	182.08
785	451.09	429.25	406.25	381.92	356.01	328.18	297.96	264.63	226.99
790	473.61	452.70	430.77	407.69	383.27	357.26	329.32	299.00	265.55
795	495.38	475.29	454.30	432.29	409.12	384.61	358.50	330.47	300.03
800	516.50	497.13	476.96	455.89	433.80	410.55	385.94	359.74	331.61

P	P_2 775	780	785	790	795
78	125.50				
785	182.71	125.93			
790	227.77	183.34	126.37		
795	266.47	228.56	183.97	126.80	
800	301.07	267.38	229.34	184.60	127.23

"Most profitable equipment I've ever used in pipe-lining"

A. T. PERRY, Supt., O. R. Burden Construction Corp.



Powering this Insley clamshell is a Cat D315 Engine, one of 21 Caterpillar units in use by O. R. Burden Construction Corp. on this Illinois pipe-line job.

Years of pipe-line building experience are represented in the O. R. Burden Construction Corp. – and with that experience has come years of association with Caterpillar products. The spread on the 86-mile Illinois line between Flanagan Station and Chicago helps tell the story. There are 14 Cat* track-type Tractors on the job, as well as 7 Caterpillar Engines powering excavating machinery.

Superintendent A. T. Perry says: "I have found that Caterpillar Engines and Tractors are the most profitable equipment I've ever used in pipe-lining. These engines are economical in fuel consumption and need few repairs. The tractors are long-lived, dependable, rugged and maneuverable."

Master Mechanic Al Lundberg adds: "Cat Engines require less maintenance than any similar equipment I've had experience with. They're trouble-free but easy to work on when adjustments are needed. And, service is always available *close* to the job."

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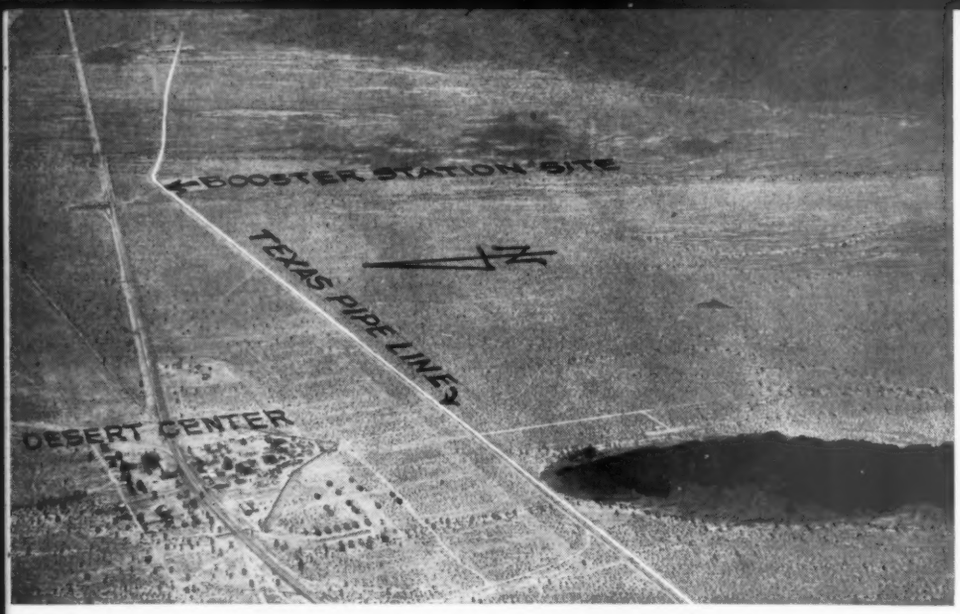


Current expansion of pipe line and storage facilities by Southern California Gas Company involves construction of two 5000-hp booster stations on Texas-California pipe line. One station is nearing completion at Desert Center (top, center) midway between Blythe and Indio, and the other is being built at Cactus Center about 20 miles east of Indio. Additional compressor facilities will be completed soon at Blythe compressor station in the form of two more 1760-hp compressors.

Mid-Winter Peak Problem

California gas companies have planned carefully and have invested millions of dollars to serve a fast growing area

RICHARD SNEDDON*

NATURAL gas pipe lines played a vital part in supplying the home cooking and heating needs of southern California's 1,750,000 gas users during the recent winter months.

Careful planning and an investment of many millions of dollars in gas pipe lines and underground storage facilities have been instrumental in enabling the Southern California and Southern Counties Gas Companies to keep pace with the tremendous population growth of southern California in the last 10 years.

Three major projects, undertaken jointly by the two companies in recent years and completed at a cost of $67,000,000, have gone a long way to help them keep abreast of the recurring mid-winter peak problem created by the increased demand for househeating fuel during relatively brief periods each year. A sufficient volume of gas must be available to take care of the heaviest anticipated winter peak loads even though they may occur only once in 10 or 12 years.

*Pacific Coast Editor.

The three projects, of course, are the well-publicized Texas-California pipe line, and the La Goleta and Playa del Rey underground storage systems.

When the Texas-California pipe line was completed just five years ago, a great valve was opened at Santa Fe Springs and natural gas from the oil fields of West Texas poured into the distribution systems of the two Southern California gas companies.

Since that time, pipe line facilities to bring Texas gas to California have been continuously expanded in a program that has seen the initial investment of approximately $100,000,000 grow to more than $500,000,000.

Natural gas deliveries of the "Biggest Inch" will soon be more than four times that of the original line, making the supply of natural gas to Southern California from out-of-state greater than all California sources combined. Upon completion of the present expansion program, Southern California and Southern

EXCLUSIVE

Counties will be receiving 555,000,000 cu ft of natural gas daily from out-of-state—compared to the 500,000,000 cu ft supplied daily by California producers.

An application filed in December, 1952, with the Federal Power Commission seeks authority for the two gas companies to further enlarge the Texas gas transmission facilities to a capacity of 705,000,000 cu ft a day. The proposed project would require installation of 73 miles of 30-in. pipe line and the addition of pumping facilities at an estimated cost of $7,500,000.

In the current expansion program now nearing completion, the two gas companies are installing 20.3 miles of 30-in. loop pipe line—a 14-mile section just east of Whitewater and a 6.3-mile section from the Blythe compressor station to the Colorado River.

When the current expansion program is completed, the California portion of the Texas pipe line will be handling 250,000,000 cu ft of gas a day more than was contemplated when the plans were drawn up in 1946.

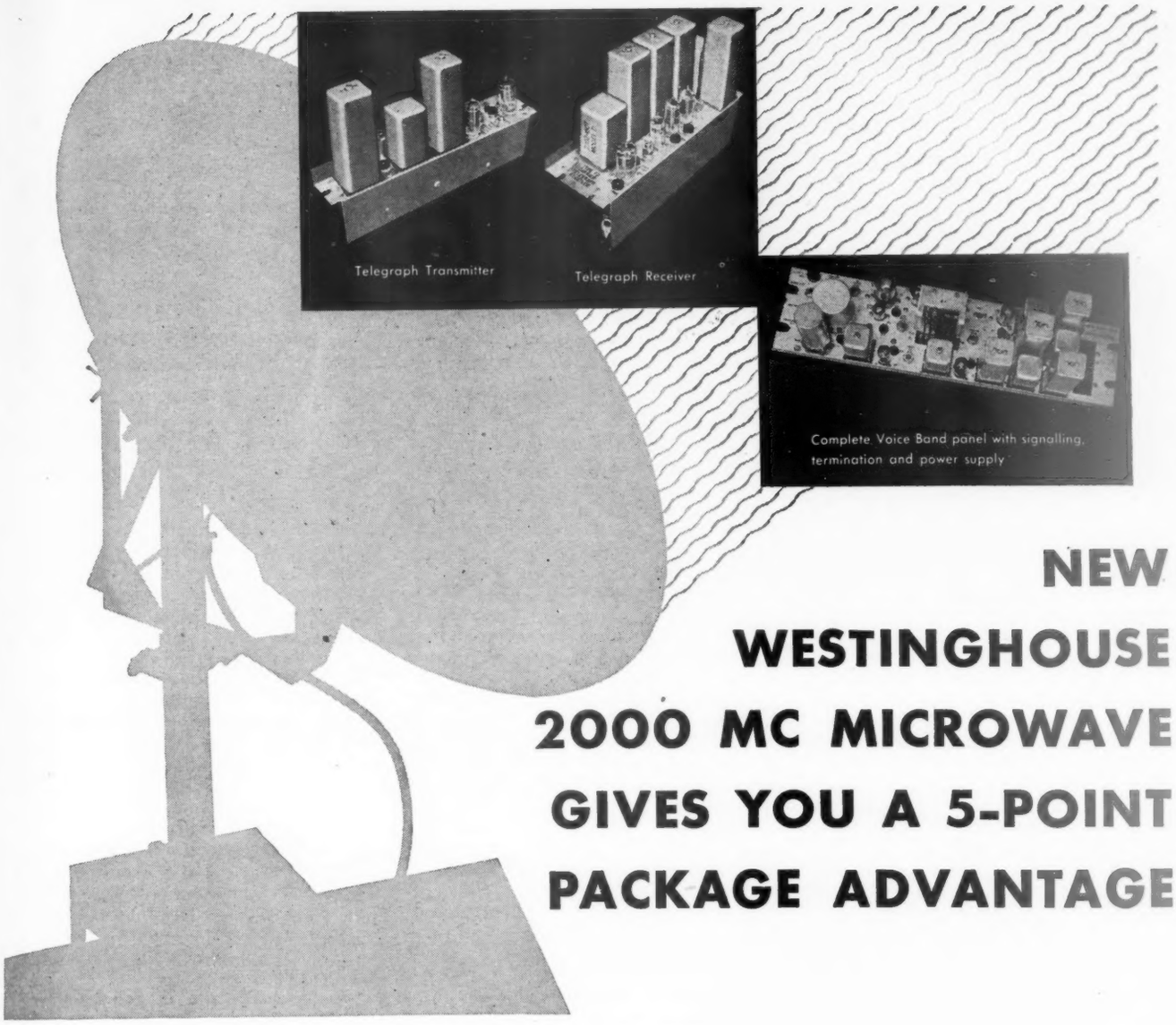
At that time, when the population of southern California was increasing at a frightening pace, the gas companies were faced with a serious gas supply problem. Drastic reductions in the amount of gas available from California oil companies had already been felt because those companies began a program of pressure maintenance through reinjection of gas into oil formations on a steadily increasing scale.

The 1200-mile Texas-California pipe line, constructed in collaboration with the El Paso Natural Gas Company, was designed to remedy, at least in part, this deficiency in natural gas supply. A pipe line was built by the El Paso company to transport natural gas from West Texas to the Arizona-California border, and another was built by the two Southern California companies to carry the gas from the border to their customers in southern California.

The California portion of the Texas pipe line today consists of the original 30-in. line laid from Blythe on the Arizona-California border to Santa Fe Springs, a distance of 214 miles, and 10 miles of 26-in. line from Santa Fe Springs to Spence station in East Los Angeles. Eighty-two miles of parallel loop line has also been installed west of Whitewater.

At the western end the pipe line connects with two feeder lines 30-in. in diameter, one of which encircles the city of Los Angeles on the south and west and connects to the transmission lines coming from the north coastal district into the Los Angeles metropolitan area. The second feeder line runs north through Puente and is connected through a lateral to the Alhambra-Pasadena area and to the San Gabriel Valley. Metropolitan Los Angeles is thus served through a gigantic high pressure loop practically encircling the entire area.

The 82-mile line completed in 1950 connects with the Puente feeder line. A 75-mile pipe line was built by Southern California Gas Company to supply Imperial Valley, and Southern Counties



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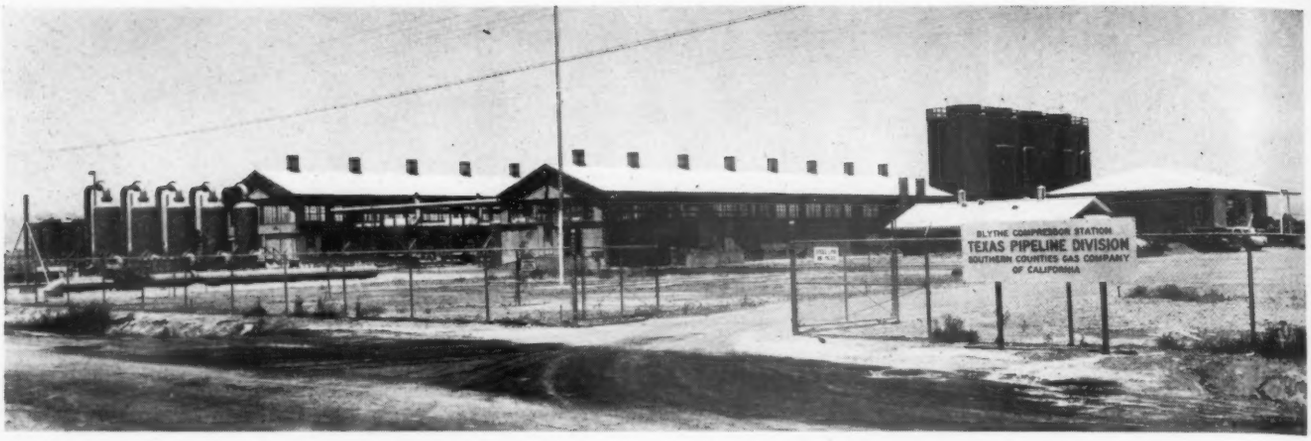


Blythe compressor station, operated by Southern California Gas Company, occupies a 50-acre site 6 miles west of the Colorado River and is used to recompress gas received from Texas at Arizona-California border. One of 4 major installations along the 1200-mile Texas-California pipe line, Blythe station has 10 compressors totalling 16,480 hp. Three more 1760-hp compressor units are proposed for Blythe in a recent application filed with Federal Power Commission.

Gas Company installed a line to supply Texas gas at wholesale to the San Diego Gas Company.

There are four stations along the California portion of the Texas pipe line, as follows, and two more are currently under construction:

1. The Blythe compressor station occupies a 50-acre site 6 miles west of the Colorado River and is used to recompress the gas received at the state border from the El Paso Natural Gas Company. The compressor plant, one of the largest and most modern plants of its kind in the country, has 10 Clark compressors totalling 16,480 hp. Seven units are 1600-hp each, and three units are 1760 hp each. With addition of the two 1760-hp units now being installed, the station will be able to handle 561,000,000 cu ft of gas a day, with standby capacity for shutdowns.

In the recent application filed with the Federal Power Commission, the two gas companies propose to install three more 1760-hp compressor units at Blythe to handle the additional volume of gas from Texas.

Completely self-sufficient, the Blythe plant has its own water wells, generates its own electricity for power and light by means of gas-driven generators, and has its own water softening system and central refrigeration system to cool the nine cottages built on the premises for plant personnel. A swimming pool and outdoor barbecue have been provided for employees' recreation.

2. The Indio division headquarters is where the division manager and his staff have offices. In addition to an office building, warehouse, and garage, six employee cottages are at this station.

3. The Beaumont station consists of a warehouse and garage used by the maintenance and patrol men who work out of this station.

4. The Brea-Olinda station, in addition to being a maintenance and patrol station, is also a pressure limiting station with a telemetric control system to the Spence Street dispatch headquarters in Los Angeles. This station is 10 miles from the western end of the 30-in. pipe line at Santa Fe Springs.

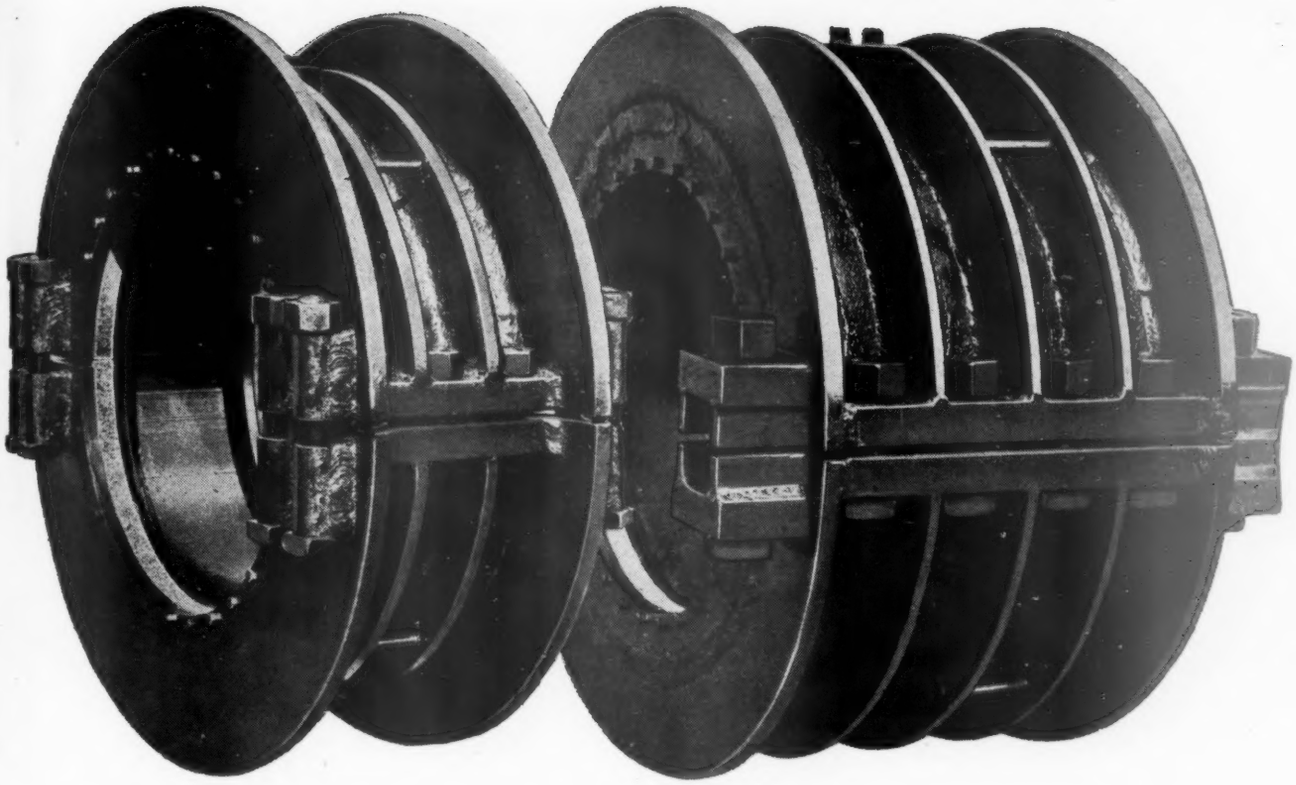
Two 5000-hp booster stations are now under construction at Desert Center and Cactus City. Gas turbine engines will be used at these stations to drive centrifugal compressors to create a gas pressure boost on the 30-in. transmission line to Los Angeles.

It took 11 hours to install 2 large valve assemblies, one at Desert Center and one at Cactus City. Photo shows section being aligned properly before welding begins.

The primary aim in going to West Texas and southwest New Mexico for natural gas was to obtain a large and stable supplementary supply to meet the steadily increasing winter peak demands of residential customers. A pipe line of this magnitude, in order to be economically feasible, however, must be operated the year around on a fairly uniform basis. Thus, the California companies must take practically the full capacity of the line summer and winter.

Fortunately, the increased growth of industry in southern California has provided a market for surplus gas during the off-peak periods. The distribution companies, therefore, have entered into contracts with various industries to deliver this gas on an interruptible basis. When it is needed for winter peak residential loads, these industries use substitute fuel. On this basis, the cost of natural gas to industries is low enough to compete with fuel oil.

Because of the extremely heavy demands for gas in winter months, it has progressively become more necessary to store larger quantities of gas underground during summer months and draw on this stored gas during the winter. Development of the La Goleta dry gas field as an underground storage reservoir is a project of almost equal im-



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These 26″ O.D. sleeves illustrate how sleeve lengths and strength may be increased as required. Both sleeves are for 1,500 psi pressures.

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Now Dresser offers you split repair sleeves for lines operating at pressures up to 1,500 psi or even higher—sleeves of various lengths, for diameters up to 30″ or larger. These are in addition to the regular Style 93 and Style 96 Sleeves for ordinary pressures up to 500 psi.

You'll want to do as many companies do—stock several Dresser Repair Sleeves for each of their principal pipeline sizes. It's cheap insurance that pays off in emergencies.

Style 93 Repair Sleeves completely enclose and repair plain, butt, bell-and-spigot and double-bell circumferential welded joints, screw collars—holes and splits in the run of pipe. Style 96 Sleeves have inside clearance enough to enclose mechanical or welded joints too large for the Style 93.

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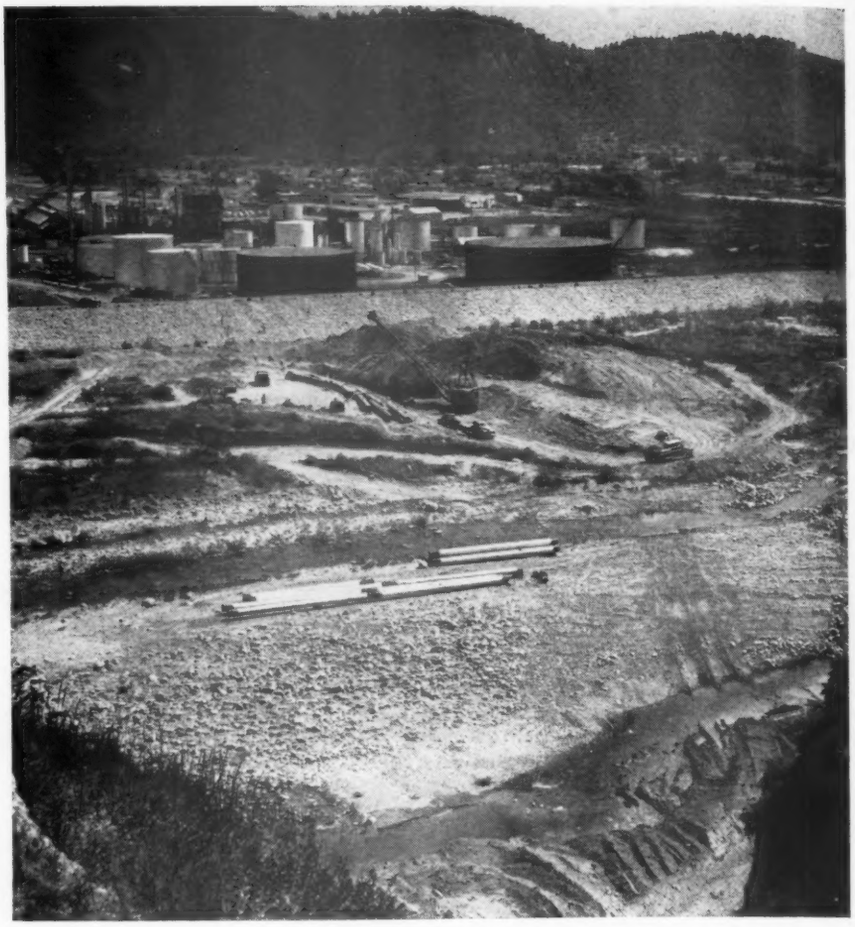
portance with the Texas pipe line project. At Goleta, located on the Pacific Coast about 8 miles west of Santa Barbara, nature has provided not only a very substantial supply of natural gas, but also a gigantic underground storage reservoir where surplus gas produced elsewhere during the summer can be stored to meet peak day requirements in the winter. Capacity of this storage area, which is owned and operated by Pacific Lighting Gas Supply Company, is about 50 billion cubic feet, and gas can be stored under 2000-psi pressure. Present deliverability from Goleta is 475,000,000 cu ft a day.

Two pipe line projects were recently completed to augment the supply of gas for southern California. The Southern California Gas Company installed an 11.5-mile section of 22-in. pipe from Ventura to the west bank of the Santa Clara River near Saticoy, and Southern Counties provided a pipe line crossing of the Ventura River. The completed project provides a completely separate 20-in. pipe line and a separate 22-in. line from the Goleta storage field to Los Angeles.

A second underground storage operation is maintained by the Southern California Gas Company at the Playa del Rey oil field near the Pacific Coast just west of Los Angeles. Although this subterranean reservoir is only a fraction as large as at Goleta—having an estimated storage capacity of one and a quarter billion cubic feet as compared to the 50 billion at Goleta—it is nevertheless more than a hundred times as large as the biggest man-made holder in the world. It has the further advantage of being near at hand for immediate gas supply whereas Goleta is about 100 miles from Los Angeles.



Pipe line crossing of the Ventura River by Goleta loop line was completed recently by the Southern California and Southern Counties gas companies. An 11.5-mile section of 22-in. line from Ventura to the west bank of the Santa Clara River near Saticoy was also installed to provide a completely separate 20-in. line and a 22-in. line from the Goleta underground storage area near Santa Barbara to Los Angeles.

Gas can now be injected at Playa del Rey at rates up to 28,000,000 cu ft a day, and withdrawn at a rate of 10,000,000 ft hourly. Two pipe lines, a 16-in. and a 12-in., connect Playa del Rey field with integrated pipe line network.

From the Texas-California pipe line and the underground storage systems alone, the two Southern California companies can now obtain a total of some 900,000,000 cu ft of gas a day when it is needed to meet peak loads. In addition to this amount of gas, some 500,000,000 cu ft daily are obtained regularly from California oil and gas operators, and another 110,000,000 cu ft can be procured for emergencies.

The 1.5 billion cubic feet thus available can deliver heat energy equivalent to 235,000 bbl of oil, or 865,000 tons of coal. To produce an equivalent amount of electric energy would require 28 Hoover Dams. * * *

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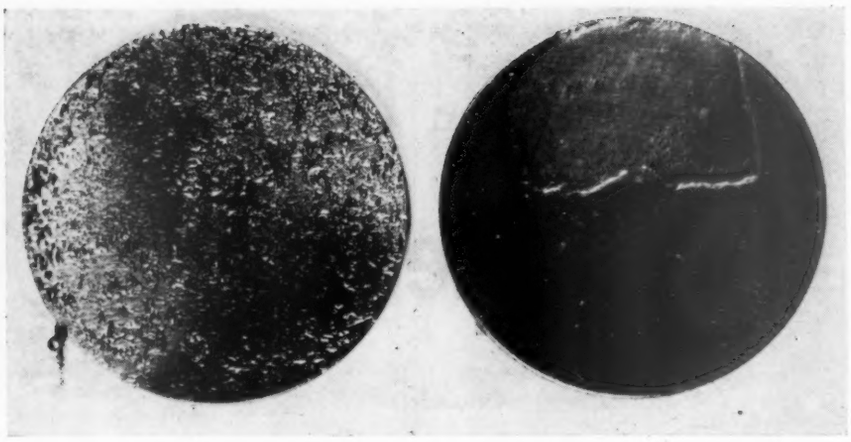

FIG. 1. Steel specimens exposed to soil corrosion for two months in the National Bureau of Standards corrosion laboratory. The specimen on the left was exposed to acid soil (pH 2.9), that on the right to alkaline soil (pH 9.5). The Bureau's study demonstrates that the rate of corrosion of laboratory specimens can be determined indirectly by electrical measurements, without direct examination or weighing.

Electrical Measurement of Corrosion Rate

Determination of pipe line corrosion rate is possible without visual inspection

A RECENT laboratory study by the National Bureau of Standards proves for the first time that the rate of weight loss of a piece of steel corroding normally in soil can be measured electrically, without actually weighing the metal. Conducted by W. J. Schwerdtfeger and O. N. McDorman of the National Bureau of Standards corrosion laboratory, the study gives further evidence that the electrochemical theory of corrosion applies generally to soils. Although the NBS measurements were restricted to the laboratory, the success of the work suggests the possibility of valuable practical applications, such as determination of the corrosion rate of a tank or other underground structure without the need for visual inspection.

When iron or steel is exposed to the soil, local differences in electrical potential develop at the surface of the metal, resulting in the formation of numerous small corrosion cells. This means that electric currents flow through the soil from certain areas (anodes) to areas of less negative potential (cathodes), with accompanying discharge of hydrogen ions at the cathodes and loss of metal from the anodes. By Faraday's law, the rate of weight loss from corrosion is proportional to the current.

The NBS-demonstrated measuring technique is based on a relationship established by other investigators, who showed that the current in a corrosion cell can be expressed in terms of the values of anodically and cathodically (positively and negatively) applied direct current, from an external source, that will just reduce the cell current (corrosion current) to zero. The relationship is:

$$i_o = \frac{I_p I_q}{I_p + I_q},$$

where i_o is the corrosion current, and I_p and I_q are, respectively, the cathodically and anodically applied currents required to reduce the corrosion current to zero. As increments of current are applied, the potential of the cell changes. When the measured potentials are plotted against the applied currents, a change in the slope of the curves usually marks the points (I_p and I_q) at which the applied currents have reduced the local corrosion current to zero.

The corrosion cells used by previous investigators in confirming the equation experimentally contained separated anodes and cathodes, so that I_p and I_q could be directly measured and the corrosion currents computed therefrom compared with values obtained by direct measurement. When a single piece of metal is exposed to a corrosive medium, however, as in the NBS study, it is obviously impossible to measure these currents directly. Here the cor-

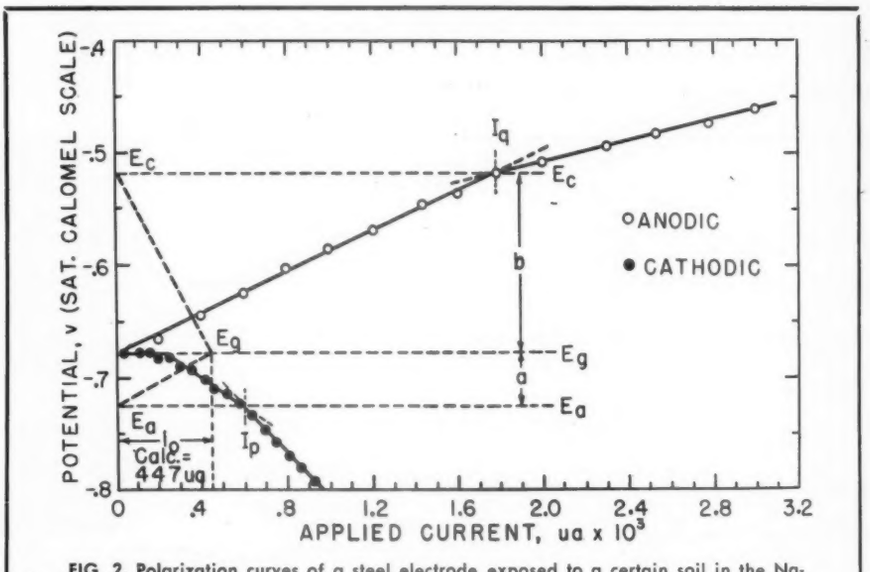

FIG. 2. Polarization curves of a steel electrode exposed to a certain soil in the National Bureau of Standards investigation. The curves are typical of ferrous materials corroding in soils. Potentials were measured with an electronic interrupter in conjunction with a potentiometric circuit. Significant changes in slope of the curves occur at values of applied current I_p and I_q. After the value of the corrosion current i_o has been calculated from I_p and I_q, the triangle connecting points E_c, E_g, and E_a can be completed. The line E_c-E_g then represents the hypothetical polarization of all the cathodic elements, and the line E_a-E_g applies similarly to the anodic elements; these lines show whether the reaction is cathodically or anodically controlled. The current I_p is the value required to prevent corrosion, commonly known as the current needed for cathodic protection. This current bears a relatively fixed relation to the corrosion current i_o, so that the latter can be estimated from the former.

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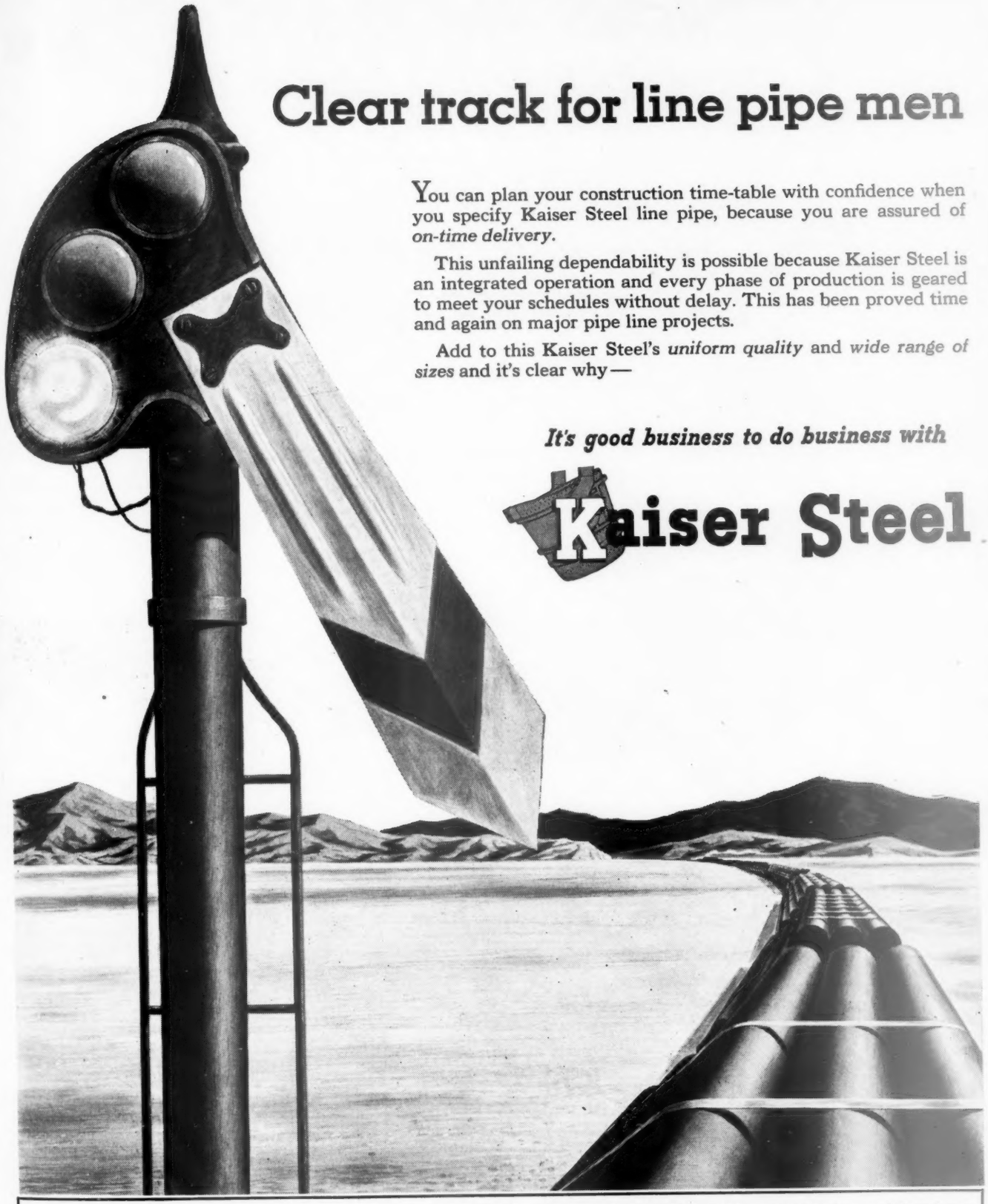

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Type	Diameter	Length	Wall Thickness	Shipping Point
Continuous Weld—Threaded and Coupled	½" to 4" nominal I.D.	Uniform 21'	Standard	Fontana, Calif.
Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance and Fusion Weld—Plain End	8⅝" to 20" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5 9/16" to 12¾" O.D.	Up to 55'	.188" to .375"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	22" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

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HERE'S HOW TO GIVE UNINTERRUPTED SERVICE SAFELY WITH MUELLER NO-BLO LINE STOPPER EQUIPMENT

WHEN IT IS NECESSARY TO REPAIR OR REPLACE A SECTION OF DISTRIBUTION PIPE OR ADD LINES UNDER PRESSURE, CONSIDER THIS TYPICAL PROBLEM AND ITS SIMPLE SOLUTION.

Maintain pressure and flow in the two 3" elements and one 2" element while the new connections are made.

Abandon 2" leaking lateral.

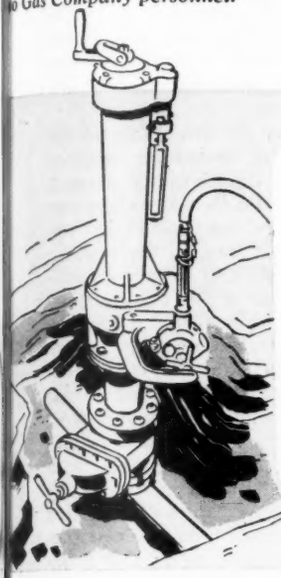
Remove leaking threaded cross; replace it with an all-welded tie-in.

STEP 1 WELD FITTINGS ONTO LINE. AREAS OF PIPES TO BE WELDED ARE THOROUGHLY CLEANED. TWO HALVES OF WELDING FITTING ARE TACK WELDED TOGETHER AROUND PIPE, POSITIONED AND WELDED TO PIPE.

STEP 2 BOLT ADAPTER AND GATE VALVE TO FITTING. 3" FLANGED LINE STOPPER FITTINGS ARE EQUIPPED WITH FLANGED ADAPTER AND 5" STEEL GATE VALVE.

MUELLER NO-BLO Method

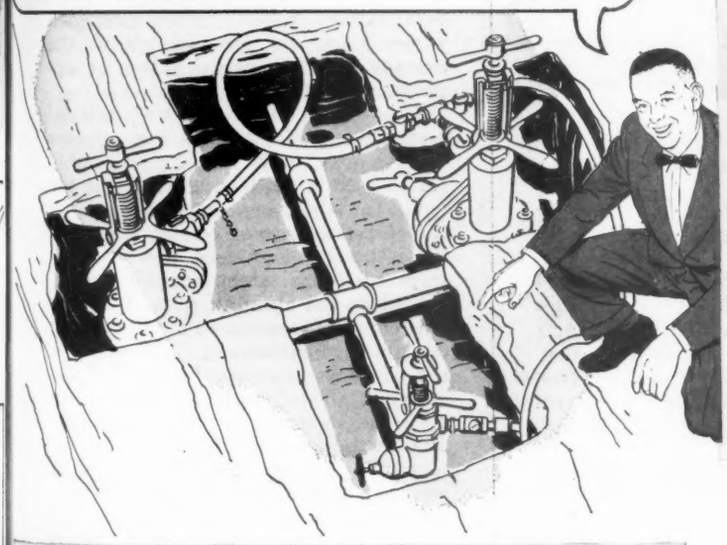
This is the first of a series of gas distribution problems and their step-by-step solution by Frank Miller, Gas Engineer of Mueller Co. Mr. Miller, narrator of the Mueller Traveling No-Blo Exhibit, is currently touring the country explaining the application of No-Blo equipment to Gas Company personnel.

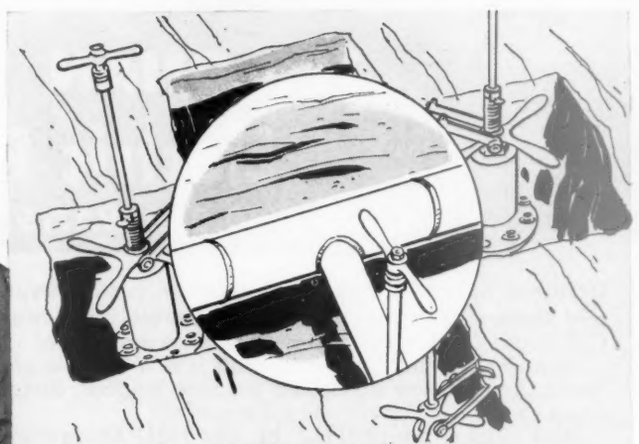


STEP 3 **MAKE CUTS THROUGH PIPE.** CUTS ARE MADE WITH MUELLER C-1 DRILLING MACHINE, POWERED WITH H-600 AIR MOTOR. AFTER SHELL CUTTER PENETRATES BOTH TOP AND BOTTOM OF PIPE, IT IS RETRACTED, GATE VALVE CLOSED AND DRILLING MACHINE REMOVED.

STEP 4 **ATTACH STOPPING MACHINES AND BY-PASS CONNECTIONS.** BY-PASS RUBBER STOPPERS ARE ATTACHED TO INSERTING BARS, AND STOPPING MACHINES BOLTED TO GATE VALVES. BY-PASS LINES ARE CONNECTED.

STEP 5 **ISOLATE CROSS.** STOPPERS ARE LOWERED AND EXPANDED, ISOLATING CROSS, BUT FLOW OF GAS CONTINUES THROUGH BY-PASS LINES AND MAINTAINS PRESSURE.





STEP 6 **INSTALL NEW TEE.** OLD CROSS CUT OUT, ONE LINE ABANDONED AND NEW TEE WELDED IN PLACE. STOPPERS ARE RAISED, GATE VALVES CLOSED AND STOPPING MACHINES REMOVED.

STEP 7 **"BUTTON UP" THE FITTINGS.** PLUGS ARE ATTACHED TO INSERTING BARS OF STOPPING MACHINES. MACHINES ARE REMOUNTED ON GATE VALVES AND PLUGS SCREWED INTO TOP OF FITTINGS. ALL EQUIPMENT IS REMOVED AND COMPLETION CAPS ADDED.

HERE IS THE RESULT:

NOTE LEAKING LATERAL IS ABANDONED AND NEW WELDED "TEE" IS IN POSITION. PROVISION IS MADE FOR FUTURE ADDITIONS OR REPAIRS.

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Both engines are 1800 R.P.M. The 13HP Onan engine which powers the CW-5 and the 20HP Onan engine used for the CW-10 weigh much less than general-purpose engines, and are amazingly compact. Built to deliver dependable, trouble-free service in heavy-duty use. Two-cylinder, alternate-firing design assures smooth, vibration-free power. New, quiet, highly-efficient vacuum air cooling drives out all heated air through *one* side duct. The same duct carries exhaust gases, simplifying installation.

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rosion current, made up of innumerable small cell currents, must be determined indirectly, if at all, from changes in slope of the current-potential (polarization) curves. The NBS study demonstrates for the first time that the total corrosion current i_o — and thus the weight loss—of a single piece of metal normally corroding in soils, and presumably in other aqueous media, can be determined by the equation, from values of I_p and I_q obtained from the changes in slope of the cathodic and anodic polarization curves.

In establishing the feasibility of the indirect measuring technique, weighed steel specimens, differentially aerated, were exposed at the Bureau to five corrosive soils for approximately two months. The soils ranged in reaction from very acid (pH 2.9) to very alkaline (pH 9.6). Because of the possibility of changes in rates of corrosion during the two-month period, polarization curves were obtained at intervals throughout the exposure period. At the end of this period the specimens were removed from the soils, cleaned and reweighed. Actual weight losses were compared with weight losses calculated indirectly by Faraday's law, using values of corrosion current (i_o) obtained from the equation on the basis of values of I_p and I_q indicated by changes of slope in the polarization curves. The calculated values of weight loss differed on the average from the actual values by approximately 4 per cent.

NOTE: For further technical details, see "Measurement of the Corrosion Rate of a Metal from its Polarizing Characteristics," by W. J. Schwerdtfeger and O. N. McDorman, *J. Electrochem. Soc. 99*, 407 (October 1952).

This technique for indirect electrical measurement of corrosion rate appears to have possibilities for extensive application both in the laboratory and in the field. In laboratory determinations of the corrosion rate of certain materials, for instance, the weight loss resulting from corrosion might actually be exceeded by the cleaning error. The electrical method makes possible much more accurate comparisons of the corrodibilities of such materials. For field determination of underground corrosion the electrical method, if it proves practicable in the field as well as the laboratory, would have several advantages in addition to obviating the need for excavating the underground object. Although in some soils ferrous metals corrode at a constant rate year after year, in other soils corrosion gradually slows down and in time may virtually cease. Actual weighing or inspection of an object that has been buried for years will indicate how much total corrosion has occurred, but will not show how rapidly, if at all, it has been corroding just prior to inspection. The electrical method, on the other hand, measures the present corrosion rate, which is likely to be of greater practical interest than the history of past corrosion. Furthermore, the electrical method does not involve the removal of corrosion products, which often inhibit corrosion. * *

Case History of a Good Public Relations Job

Mid-Valley's program to "win friends and influence people" provides a practical pattern for other pipe line companies

THIS is the story of "Operation Better Public Relations" — a factual review of a practical public relations program that has successfully enabled one major oil pipe line operator — Mid-Valley Pipeline Company, of Longview, Texas —to win thousands of new friends, increase its prestige, and gain incalculable goodwill as an industrial citizen.

It is particularly timely, too, in view of the tide of anti-pipe line sentiment that, having risen steadily in recent months, brings into sharper focus a long-pressing need for pipe line officials to strengthen and intensify their public relations policies and activities.

Oil and gas pipeliners seeking a solution to this problem may find a study of Mid-Valley's efforts quite illuminating, for they provide a pattern for positive action that can prove helpful to other pipe line operators interested in improving their community relations.

Mid-Valley's program was developed with the intention of reaching, as nearly as possible, everyone affected by the firm's operations as a crude oil carrier over a 1000-mile route from Longview, Texas, to Lima, Ohio. Most important members of Mid-Valley's "public" are chiefly of three classifications.

First, there are some 4000 property owners through whose land the line passes. Next, there are neighbors and friends of the company — local residents — in 15 communities of 7 states where the company operates pumping stations, district offices, or district warehouses. Then there are Mid-Valley's employees themselves.

Six-Purpose Program

The program had six basic objectives at the very outset. Through it Mid-Valley sought to:

1. Establish more friendly relations with some 4000 landowners, principally farmers.

2. Give local residents and business leaders of 15 communities (where Mid-Valley maintains field installations) a clear, close-up view of the organization, its operations, its facilities; also, to give these friends and neighbors a picture of the petroleum industry generally, and of Mid-Valley's participation specially.

3. Give everyone affected directly or indirectly by Mid-Valley's operations a clearly defined statement and expression of company policies on right-of-way maintenance, local employment practice, purchasing procedure, etc., thereby promoting wider knowledge and understanding of such policies by property owners, employees, and the public.

4. Accomplish the same broad objectives with employees and suppliers interested in the company's continued progress.

5. Point out the economic and social significance of the petroleum industry to the nation and Mid-Valley's contribution along these lines to the areas where the company operates.

6. Stimulate greater goodwill and spur wider recognition in the public eye of the company as a progessive enterprise and industrial citizen in the typical American tradition under the competitive system.

To carry out this six-purpose program, Mid-Valley utilized three "basic tools." These were: (1) A special factual brochure; (2) personal contacts of selected company representatives with property owners, and (3) a 1000-mile, system-wide open house celebration for neighbors and employees. These tools were carefully coordinated to achieve maximum coverage and effectiveness.

Partners in Progress

Job No. 1 in the overall plan was the preparation of special literature giving the "what, when, why, and how" of the Mid-Valley organization.

Built around the theme, "You and Mid-Valley ... partners in progress," this publication is a picture-style, three-color, 32-page brochure "presenting a portrait of a pipe line at work serving mid-America." Non-technical, liberally illustrated, it tells and shows why petroleum promotes progress, how Mid-Valley pushes petroleum through a pipe line, and the scope of "Mid-Valleyland."

Detailed treatment is given to Mid-Valley's main mission of economical oil transportation, how Mid-Valley moves oil and what it takes to transport 235,000 bbl a day from Longview, Texas, to Lima, Ohio. Highlighted in this connection are dramatic views of the various types of equipment used in Mid-Valley's eight diesel and five electric pumping stations, the important part communication plays in oil shipping, and how maintenance, safety, and good housekeeping also vitally affect pipe line transportation of oil.

An outline of Mid-Valley men and management, their aims and objectives, and the company's role as a citizen and neighbor in the communities where it operates and maintains facalities, concludes the interesting presentation. By means of this brochure, Mid-Valley presents the layman with a kaleidoscopic view of the company's activities and operations, quickly grasped and easily understood by anyone not familiar with the organization. At the same time, it serves as a vehicle for public expression of company policies and aims.

Property Owners Visited

Personal visitation of property owners was Step No. 2.

Armed with the booklet, pump station foremen or other appointed personnel visited every Mid-Valley property owner along the entire line. Attention of each was directed to some of the more important factors cited in the booklet relating to him as an individual.

The visit also enabled the station foreman and the landowner "to talk over together" damage claims and other right-of-way problems on a completely frank yet friendly basis. Invariably, these visits were welcomed by landowners; many of them had never seen a Mid-Valley employee since the day the roddage and/or damage check was handed to them by a company agent.

Following these personal visitations, the company held a whole series of open houses — one for each 13 different stations in different localities. Each open house lasted two days.

Foremen and other station personnel had been thoroughly briefed on the company's plans, of course, and each man received specific assignments. Once management had explained the complete program and its purpose, the men quickly accepted it enthusiastically, welcoming it as an ideal opportunity to tell and sell the story of Mid-Valley as an employer, citizen, neighbor, and consumer.

Accordingly, while visiting property owners, each foreman presented the individual owner with a personal, written invitation (and a map giving directions) to attend open house at his nearby Mid-Valley pumping station. Officials of chambers of commerce, service clubs, and other civic associations and social groups in each community were also contacted personally and presented with copies of the brochure.

Meanwhile, everything was "made

TOUGH ENOUGH for the Job

Your WATE-KOTED pipe will probably never be subjected to this particular type of abuse, but loading, unloading and laying can exert a lot of strain on it. That's why all Rosson-Richards WATE-KOTED pipe is uniformly reinforced with Key Mesh Wire or Single Strand Wire to provide an adherent material almost as strong as the pipe itself.

WATE-KOTE is not only the heaviest weighting material of its type yet developed, but is tough enough to take a lot of punishment during laying operations. WATE-KOTE was developed by Rosson-Richards to lick the tough job of laying pipe through open water, rivers or marshy ground. The high strength and high-density of WATE-KOTE make it the ideal weighting material to keep pipe on bottom.

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ready" at each pumping station for a steady stream of visitors. Although Mid-Valley normally practices high standards of housekeeping in its pumping stations, extra efforts were extended in this direction. Exterior and interior walls, piping, and equipment were put in spic-and-span condition.

At the same time, some 34 daily and weekly newspapers serving "Mid-Valley-land" were contacted. Editors were supplied with the "You and Mid-Valley" booklet, and news releases and pictures. In virtually every instance, cooperation given by the local press was excellent.

When open house days arrived, station personnel were on hand to explain interesting things to visitors, who received a copy of the booklet. Every Mid-Valley employee was a guide; each explained what the job of oil pumping entails. Each employee displayed a vast knowledge of the station and its equipment; every Mid-Valley man who took guests on a "Cook's Tour" through the installation proved an expert no less!

Particularly interesting to note is the fact that Mid-Valley employees and their wives — voluntarily and on their own time — acted as company hosts. Result: A friendly, congenial atmosphere that made visitors feel completely at ease and "right at home," so-to-speak, adding to enjoyment of the occasion.

They Came, Saw, Learned

Singly and in groups, visitors came and saw Mid-Valley at work. They looked and learned how Mid-Valley does its oil-transportation job. They saw the pumps, prime movers, integrated electrical controls, audio and visual safety signals, and a whole host of auxiliary apparatus required by Mid-Valley to move oil on a continuous, round-the-clock schedule over long distances with maximum efficiency, safety, dependability, and economy. Guests returned to their firesides with a better understanding and broader appreciation of the company, its facilities and its operations.

Altogether, between 2500 and 3000 people visited Mid-Valley's 13 pumping stations — this despite the fact that many of the areas traversed by the line (through Mississippi, Tennessee, and Kentucky especially) are sparsely settled; and further, that these stations are situated in out-of-the-way places not too readily accessible by car, the location even then being anywhere from, say, two miles to ten miles out of town.

Number of visitors at the different stations ranged from 25 — this at Longview, Texas, in the heart of the oil fields, where pumping stations are an everyday sight — to 650 is Pyrmont, Ohio, where a pumping station, being a new addition to the local scene, attracted considerable attention, even though it was not yet in operation.

What Results Were Accomplished?

Was "Operation Better Public Relations" worthwhile? In every way, Mid-Valley reports. In fact, results far exceeded expectations in a number of different ways. For example, as a result of the personal contact made between the local pumping station foreman and his neighbors, he realized clearly as never before that, in the eyes of the community, he really represents the company. The feeling that he is an integral part of Mid-Valley was brought home to him with new forcefulness and clarity.

Consequently, Mid-Valley's station foremen are now completely cognizant and conscious of their dual responsibilities: To local property owners who extended the courtesy of granting right-of-way permits in the past, and to the community as a whole. Also, they have become equally aware of their acceptance in their respective communities as representatives of the company.

The program may be said to have developed, then, a feeling among foremen that management of pipe line operators and others in the oil and gas industries have tried to put across in various ways for years, namely: As members of the management team, foremen are part and parcel of progressive management.

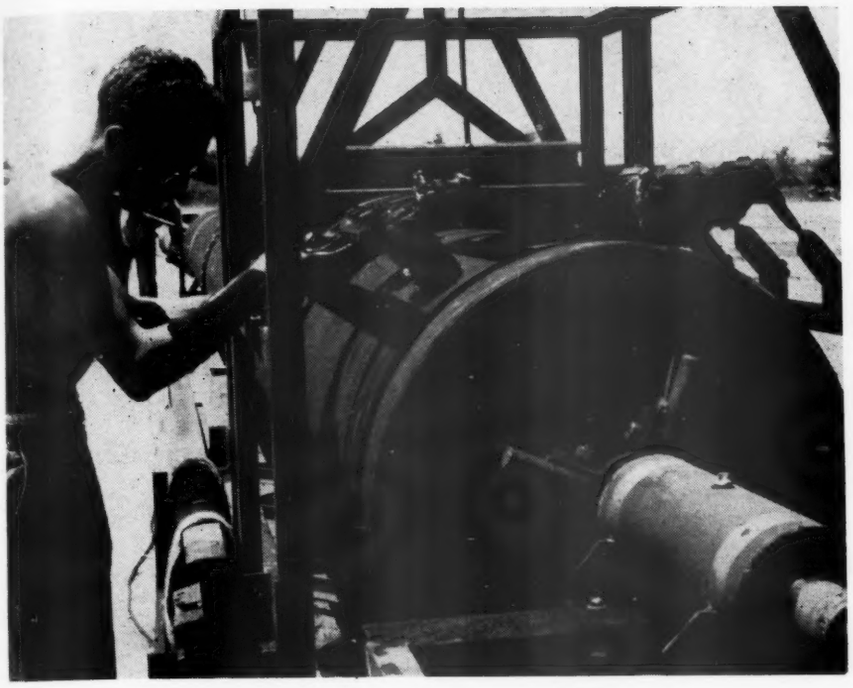
Secondly, grievances and complaints of property owners revolving about poor right-of-way cleanup, maladjustment of damage claims, and so on, have been brought to light —either through direct contact with foremen or correspondence with Mid-Valley's home office — so that prompt remedial measures could be taken.

Everybody, including Mid-Valley's employees, learned more about the company's operations, how it functions, its part as transporters in the general petroleum picture, and what the organization contributes to continuing community growth and development in the areas where the company operates.

Mid-Valley's experience seems to indicate that there undoubtedly exists a definite need among pipe line companies to win more friends and earn greater goodwill through improved public relations. The souvenir brochure, personal visitations with property owners, and the series of open houses mark three initial steps in this direction.

The company plans, of course, to follow up these efforts to keep alive the more friendly relations gained among property owners and others. Already, for instance, Mid-Valley is preparing for distribution to property owners "farm calendars" giving the name, address, and telephone number of the nearest pumping station and division office to call in the event a landowner discovers a leak or washout of the line on his property.

One additional point is worthy of special note in conclusion. Mid-Valley staged special open house celebrations for employees and their families at each station on the evening preceding public visitations. Holding this special preview for employees proved worthwhile in many ways, too. It served to re-emphasize to every station employee why his job is important; it gave families a better understanding of their man's job; it fostered friendlier cooperation through management and employees working together. * * *

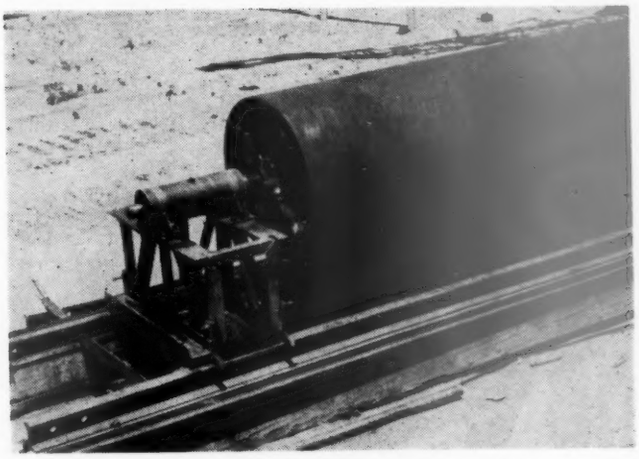


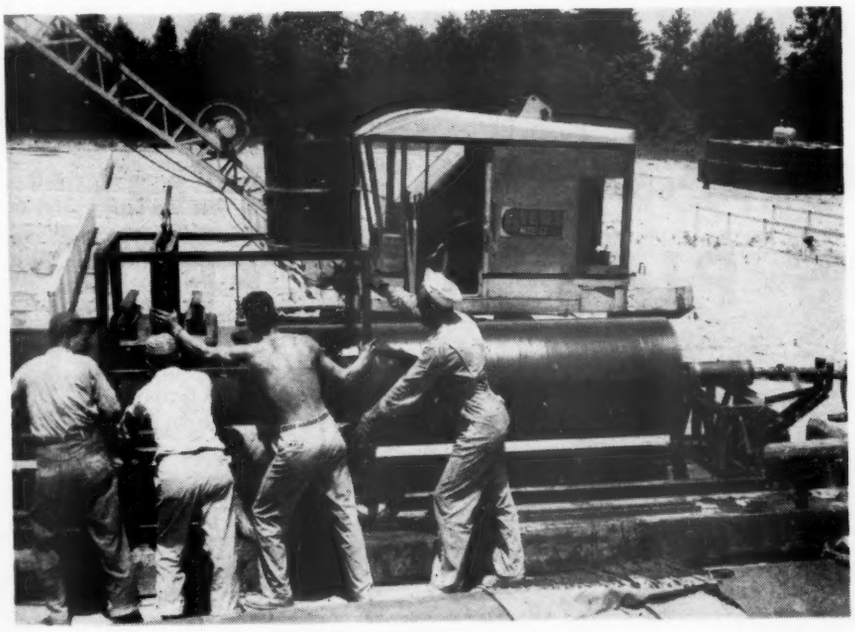
Edwin P. McDonough, maintenance man, adjusts the paint brushes.

At the ends of the rig are spiders on axles that operate through discarded fin-fan bearings. The two spiders fit snugly into the ends of the pipe joint and support it.

Pipeliners Devise Own Rig to Clean and Paint Pipe

Transcontinental men display ingeniousness by developing equipment from used materials

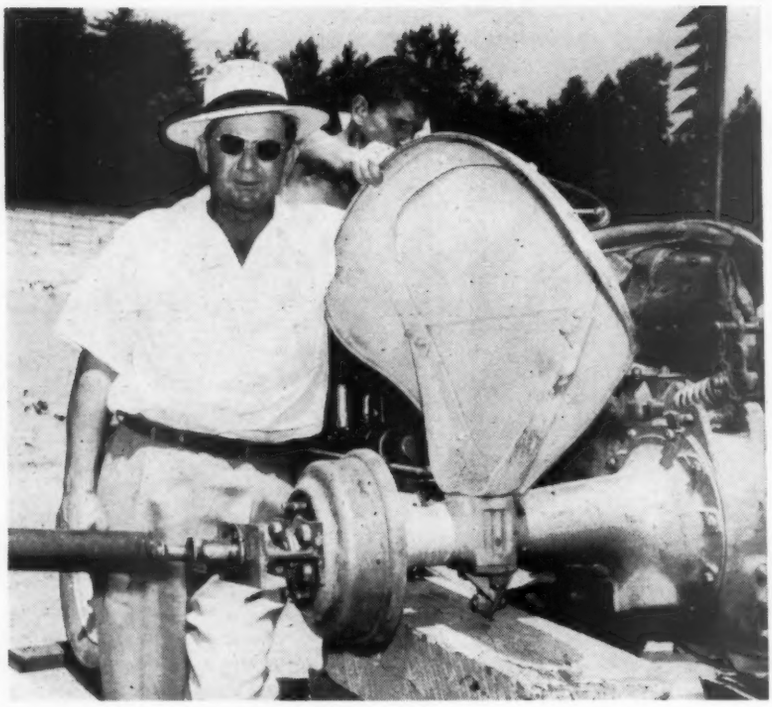




PERSONNEL of Transcontinental Gas Pipe Line Corporation's District 6 in Georgia have developed a rig that will clean and paint a 40-ft joint of 30-in. diam pipe in 8 min, record time. That is the time required for the pipe joint to travel from the rack, through the rig, to the rack of cleaned pipe.

(Continued on Page D-68)

As the pipe turns, the cleaning rig is moved along. The machine contains weighted wire brushes that clean the pipe. Immediately behind the brushes is a spigot that drops paint on the clean pipe. Behind the spigot are brushes to spread the paint.
Workmen in the picture are Clarence G. Loving, left, Leonard J. Hawkins, McDonough, and B. F. White.



Pipe is revolved by connecting one axle to a Fordson tractor. Superintendent McGehee stands beside this connection; behind him is McDonough.

Each joint of pipe is lifted in and out of the rig by a dragline used as a crane.

The rig, developed by pipeliners working with Superintendent V. R. "Pete" McGehee, was constructed from used materials available in the district. McGehee says that every piece of material used in the rig can be reconverted to its original use at any time. The following pictures shows the various steps involved in the process. * * *

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This Nicolet development is now available after months of intensive research and field testing. If you would like a sample of VITRABESTOS for close examination, write direct to Middle West Coating and Supply.

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Pitt Chem's *specified* top quality means better protection underground, too, for it allows a better bond and greater resistance to soil stresses and varying service temperatures. ● Write today for *Pitt Chem* specification sheets . . . or any help you may need on your particular coating problem.

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Republic Electric Weld Line Pipe

REPUBLIC Electric Weld Line Pipe is formed from flat-rolled steel . . . the same thickness from side to side and end to end. The result is line pipe that is uniformly thick, uniformly concentric from end to end. *You* benefit because your crews can line-up ends quickly and welding crews can produce uniform weld beads at uniform speeds.

Clean surfaces inside and out provide freedom from holidays in protective coatings, prevent clogged valves and regulators caused by scale loosened after blowing-out the line.

Across the nation, more than 67,000 miles of Republic Electric Weld Line Pipe and 24 years service on many of these miles prove that Republic is the name to specify for pipe on transmission, gathering, products, and distribution lines.

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Other Republic Products include Casing and Tubing—Carbon, Alloy and Stainless Steels—Studs, Bolts and Nuts—Heat Exchanger Tubes

EXCLUSIVE

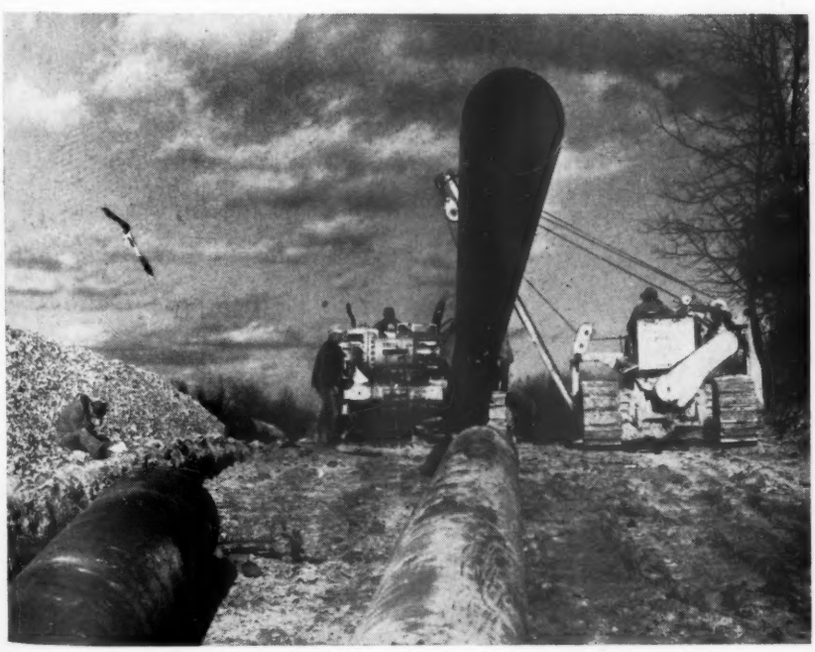
A pipe gang struggles to finish an important section of the Texas Gas job on one of the muddiest right-of-ways ever seen.

ABOUT April 1 construction will begin on 45 miles of 26-in. loop lines between Slaughters and Louisville, Kentucky, for the Texas Gas Transmission Corporation. This will be the final laying of loops that began last year to bring the transmission company's delivery capacity up to 950,000,000 cu ft of gas a day. The rest of the project was completed before the end of 1952 in time to help with peak load requirements, although to do so contractors had to extend their activity far past the time of good pipelining weather. In fact, crews of the contractor on the northern end of the line, H. C. Price Company of Bartlesville, Oklahoma, even worked on Christmas and New Year's Day in order that homes, schools, hospitals, and churches might have sufficient heat for the cold winter months. The last important loop was completed near Halls, Tennessee, on January 2; then the work was shut down, permitting overhaul of the equipment used and providing a welcome

Major Part of Texas Gas Project Completed

Work to be resumed about April 1, will increase system's capacity to 950,000,000 cu ft a day

A bend is made in a joint of pipe so it will fit over a hill.



E. E. Ogle, Spread-Two welder, uses handmade scaffold for support while working underside of joint of 26-in. pipe.

The chill winds of an early winter had already stripped the trees of their foliage as this big dozer went to work on the cleanup of a long stretch of right-of-way.

A shiny coat of primer paint is left on the pipe by the "whirling wings" of this cleaning and priming machine as a Spread-Three employee adjusts it.

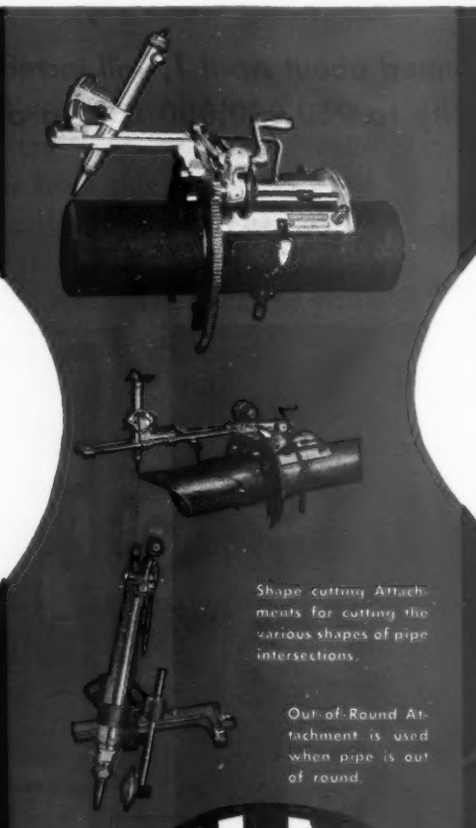
vacation for a group of tired pipeliners.

The Price organization, with four spreads, has laid a total of 321 miles of pipe line and will lay the 45 miles in Kentucky mentioned above. From Beekman station, near Bastrop, Louisiana, north to the Mississippi River, Houston Contracting Company, Houston, Texas, laid 46 miles of 26-in. pipe.

The overall project, which also included the installation of a 3960-hp compressor station at Houghton, Louisiana, to pump gas from the Carthage field, Texas, will increase the capacity of Texas Gas' system by 240,000,000 cu ft a day.

The accompanying photographs were taken on H. C. Price Company spreads in Mississippi, Tennessee, and Kentucky, and are used here by courtesy of that company. * * *

For Easier, Faster, Pipe Cutting & Beveling



Shape cutting Attachments for cutting the various shapes of pipe intersections.

Out-of-Round Attachment is used when pipe is out of round.

Economical...

With the economical H&M you can save up to half of the time and labor in cutting and beveling pipe. This portable but durable machine makes a complete cut and bevel in a 12 inch pipe in about two minutes.

See for yourself. Let us arrange a demonstration.

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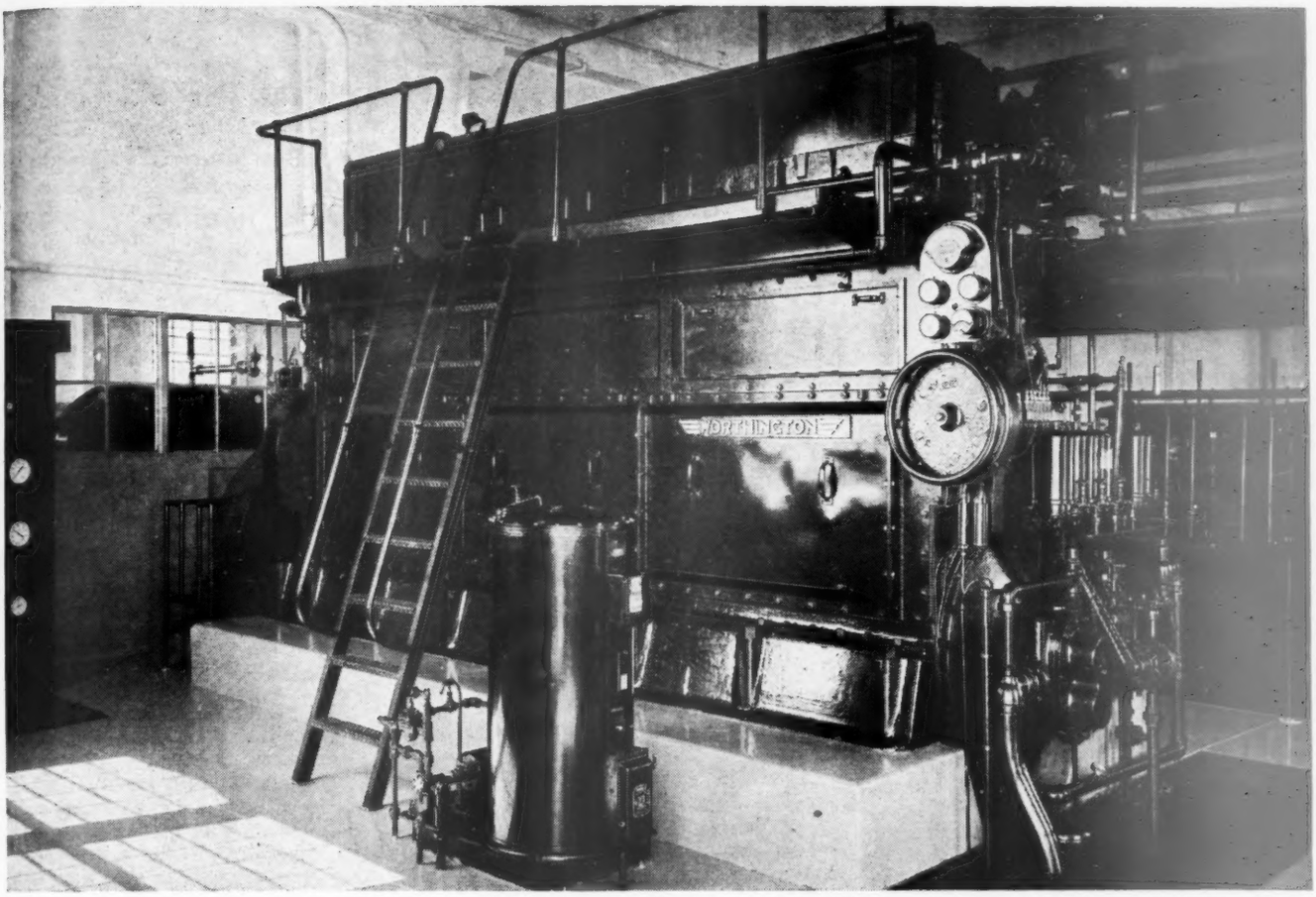

No Standby Needed

Worthington Reliability Saves Thousands of Dollars in Investment Cost

Here's one of twelve Worthington Diesel engines used exclusively on a large oil pipe line running across Texas.

They power the pumps which maintain a constant flow of crude oil from field to refinery.

In none of the pumping stations is there a standby engine. The pipeline company is confident that its Worthington Diesels will *stay on the job.*

Portable pumping units are connected into the line during routine maintenance checks.

Engine fuel is raw crude bled from the line. This is a severe application. But Worthington — one of the first to utilize crude for Diesels — knows how to lick the problem.

For any engine application, call on Worthington — an engine for any fuel: oil (crude or regular), gas or "dual fuel." Worthington's complete line of engines assures you of the most economical operation no matter what fuel you use.

For further information, write Worthington Corporation, Engine Division, Buffalo, New York.

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ENGINES

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ECONOMICAL CONTINUOUS POWER

Diesel Engines, 150 to 2640 hp
Gas Engines, 190 to 2880 hp
Dual Fuel Engines, 345 to 2640 hp

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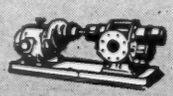
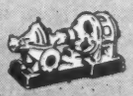
Engine Starting Compressors



Oil Transfer Pumps



Cooling Water Circulating Pumps

Evaporative Type Engine Water Coolers

The Contractor and the Landowner*

Manner of conducting construction operations has important bearing on future relationship of owner company and property owner

CHARLES A. LINGO†

It is indeed a pleasure and a privilege to be afforded the opportunity to appear before a group of men whose efforts and accomplishments have had so vital a part in our national economy. In fact, you are to be congratulated on the remarkable success that has attended your construction ventures in all parts of the world. You have been a contributing factor in making available to civilization generally the advantages of the natural resources of gas and oil and their by-products.

For a few minutes I would like to relate how we at Tennessee Gas Transmission Company think your construction operations may be conducted in order that such operations will be reasonably compatible with those of the landowners, and thereby result in more cordial relations. We feel that it is highly important in our transmission operations to gain and maintain the goodwill of all the landowners and tenants over whose property we operate our facilities. This was a goal when we operated only one pipe line, and it has become more and more desirable and necessary now that we have as many as four pipe lines crossing the property of a large number of landowners. We have come to know these people more intimately than is possible where we operate a single line. We have become acquainted with some of the problems of their operations, which have come about either directly or indirectly as a result of the lack of thought and planning prior to the entry of construction crews. We are giving a great deal more thought to these matters with the idea in mind to correct past errors, prevent the creation of additional problems, and to make our association with the landowners more harmonious and compatible with the uses they make of their property. We value their goodwill and cannot stress too often the necessity to so conduct your operations that we do not alienate these friends.

It is our firm belief that a substantial amount of the ill will that has been created in the past has stemmed from two principal causes. These we believe to be, first, your personnel's lack of understanding of the exact rights that the landowner has granted to the pipe line company; and, second, the failure to respect the landowner's rights and abide strictly by the terms of the easement grant.

C. A. Lingo, vice president, Tennessee Gas Transmission Company.

Just what are the rights that have been granted? The authority by which a pipe line is generally constructed is known as an easement grant or a right-of-way grant. This authority is limited in its scope in that it lists and restricts the privileges granted. The landowner retains title to the land and merely conveys a right to do specific things. He retains full ownership and his right to continue to fully use the land is subject only to the rights granted to the company; namely to lay, construct, maintain, operate, repair, change the size of, and remove a pipe line. These general rights are defined more specifically in that the company and the contractor are permitted to do only those things that are necessary to accomplish the laying, maintaining, etc., of the pipe line. The landowner at the time he executed the easement did not intend that his property was being opened to the company to do as they or its contractors might desire to do. He expected to be able to maintain his operations in a normal manner, although he anticipated the necessity of construction people and machinery being upon his land for the time necessary to accomplish the job they were engaged to do. He knew that his fences would be opened and his crops and timber damaged or destroyed upon the right-of-way. He realized there would be an interruption of the otherwise normal tranquility about his farm or tract of land, and to these things he was reconciled. But the things that made his temper rise were those that materially interferred with his day-to-day routine. Specifically, he dislikes his fences being left open, or unattended, with the result that his cattle stray, become mixed, lost, or killed upon a public road. He dislikes having to carry feed and water to his livestock because they cannot cross the pipe line ditch and get these necessary items at the customary location. The use of his private roads and drives are irritating to him and his family, particularly when construction equipment, cars, or trucks block his way; and he loses valuable time while waiting for a passage-way to be opened. The list of complaints is, as you probably know, quite long; but the majority of them are legitimate in that they violate in some manner a right of the landowner. The following list of "Don'ts" is suggested as a means to reduce the number and the nature of the complaints:

1. Don't leave gates, gaps, or fences open, unattended or insecurely fastened.
2. Don't permit livestock to stray or become mixed.
3. Don't permit the personal misconduct of your employees.
4. Don't use excessive charges of blasting powder or dynamite.
5. Don't leave trash and debris on the land.
6. Don't use without authority land beyond the limits of the right-of-way.
7. Don't use private driveways or roadways without authority.
8. Don't isolate livestock from feed and water.
9. Don't obstruct drainage.
10. Don't violate local, state, or federal laws.

Provide your supervisory personnel with the specimen copies of the right-of-way grants, together with the list of the special provisions, which if not readily supplied by the company, you should request. Insist that your personnel is properly instructed relative to terms of each right-of-way in order that they may be fully advised concerning any restriction or any special provision with which they must comply. Failure to comply usually results in a claim for damages, which may wind up in the court house; and frequently the failure to abide by the provisions of the right-of-way contract leads to work stoppage by court order. In both instances unnecessary expense and ill will result. This ill will

*Presented before the Pipe Line Contractors Association, Houston, Texas, January 19-21, 1953, under the full title "How A Pipe Line Contractor Affects Company Relations With Landowners."

†Vice president, Tennessee Gas Transmission Company.

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Yes, it weighs less and covers more pipe footage per pound. The result is substantial savings in freight and handling costs.

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You can coat more feet of pipe per man-hour because less material is required. And, because there are no irritating fumes, pipe line crews prefer working with NO-OX-ID.

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With NO-OX-ID you need less equipment in the field. Fewer "dope" kettles, trucks and "cats" mean reduced construction and labor costs.

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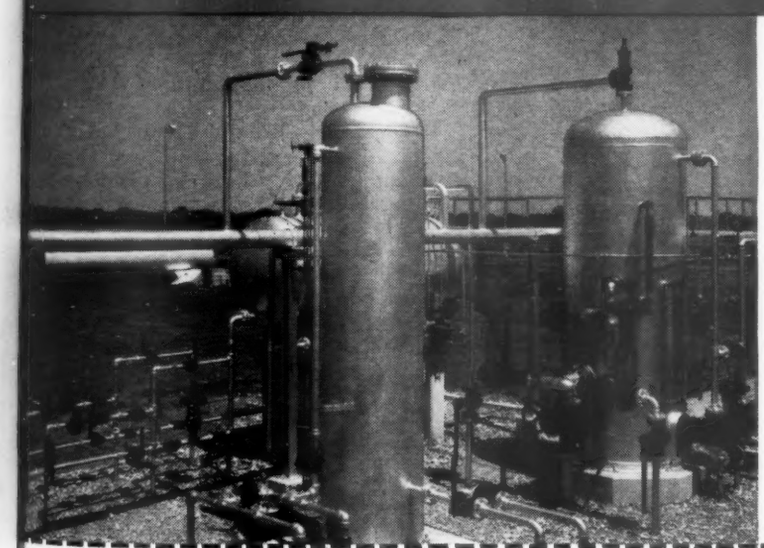
Let us demonstrate...with facts, figures and photographs...how Dearborn NO-OX-ID coating combinations give the longest possible life to your pipe line by combining chemical and mechanical protection.



Do you know about NO-OX-ID aluminum protective coating?

To provide maximum protection—and attractive appearance—to outdoor tanks, gas holders, pumps, piping, etc., investigate NO-OX-ID 5C Primer and Aluminum Protective Coating. Highly durable, it resists abrasion, fumes and mild chemical attack. Write for Bulletin.

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XUM

is particularly in evidence when another right-of-way is sought by a pipe line company. More restrictive provisions are made a part of the grant to such extent it becomes burdensome, if not impossible, to construct a pipe line.

As stated before it is our belief that the legitimate complaints and the ill will that follow, for the most part are caused by the lack of knowledge of the landowners' rights and reservations, and not from a malicious and willful act on the part of your workmen. It is most difficult at times, however, to convince an irate and abused landowner that your operations in all their phases are not the works of the devil, and designed to destroy his property, leaving destruction and desolation in your wake. It is unfortunate but true, that some jobs have been so conducted, and the land left in such a state of repair, that would lend considerable substance and credence to this belief. In the past several years much progress has been made toward the elimination of the standard complaints, and it is sincerely hoped that you will continue to exert your efforts and influence to the end that all complaints may be eliminated.

We have made it a policy in our company to provide the contractor with all possible assistance in getting the construction job satisfactorily completed. In addition to supervisory and inspection personnel, our land agents are familiar with the many problems that confront you in your construction work. Several land agents are assigned to each spread to be available to adjust complaints as they arise, in addition to their other duties. The land agent, due to his previous contacts with the owner and tenant, is familiar with any operation that the landowner or tenant may conduct on the premises. Request that he acquire any additional rights or privileges that you may deem necessary or convenient to your construction work. Report all complaints to him and request that he negotiate a mutually satisfactory settlement of any claims that may justly be asserted against you. His function may be described as that of a liason man between the company and the landowner; let him operate in that capacity for you also.

After your construction work has proceeded beyond the point of getting the pipe in the ground and the ditch backfilled, from the standpoint of the landowner there remains several chores to be done, which if accomplished promptly will go a long way in promoting and encouraging the relations most desired between the landowners and the company. Complete the clean-up and rebuild the fences in the presence of the landowner or his representative in order that any suggestion or complaint that he may have can be handled at that time. Leave the premises in as neat a condition as is possible and his fences in a state of repair as good if not better than they were before you entered. Restore the private roads you might have used; repair bridges or culverts your heavy equipment might have damaged. Do these things immediately after backfilling the ditch in order that the landowner may resume his operations, which might have been halted by the presence of your equipment and work.

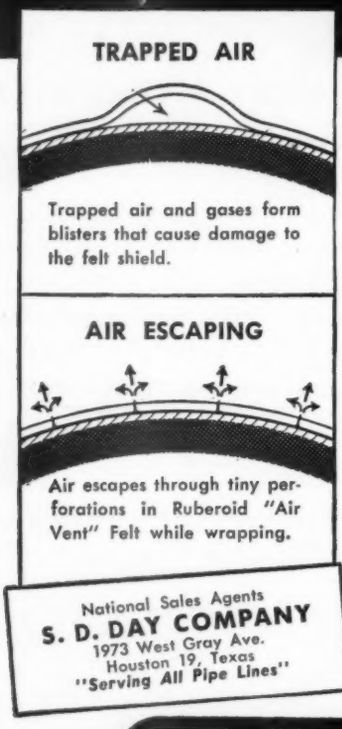
In conclusion, I would like to emphasize that your personnel can do much in formulating the attitude landowners have toward pipe line companies and pipe line construction companies. The men in the field influence the opinions that are formed of our respective companies. Their contacts with the landowners or the tenants can be helpful or it can make our job of maintaining goodwill the more difficult. The attainment of the highest degree of goodwill is of importance to all of us, and your continued efforts in that regard will result in our mutual benefit. * * *

☆ ☆ ☆

Lone Star Lays Line to Jameson Field, Texas

Lone Star Gas Company has tapped the Jameson field in a move to strengthen the gas supply for distribution systems in Taylor, Nolan, Mitchell, and Scurry counties.

Gas from the Jameson field in northwest Coke County will be delivered through a 25-mile pipe line of 8-in. diameter recently completed. The line extends northwest from a point near Silver to Lone Star's transmission network about 4 miles southwest of Colorado City.


TRAPPED AIR
Trapped air and gases form blisters that cause damage to the felt shield.
AIR ESCAPING
Air escapes through tiny perforations in Ruberoid "Air Vent" Felt while wrapping.

Trapped air, gases and surface moisture that lead to damaging pipe line blisters are eliminated with Ruberoid's new Asbestos Perforated "Air Vent" Pipe Line Felt.

"Air Vent" is made with tiny pin pricks through which air and gases escape during the wrapping process. After wrapping, hot enamel fills the voids. When it cools, it hardens and produces the action of miniature rivets between pipe and felt. The perforations give "Air Vent" added flexibility, too, enabling the felt to grip the pipe much tighter.

You get all these advantages in a pipe line felt that costs you no more. So write for your free sample, today. Pipe Line Felt Dept., The Ruberoid Co., 500 Fifth Ave., New York 36, N.Y.

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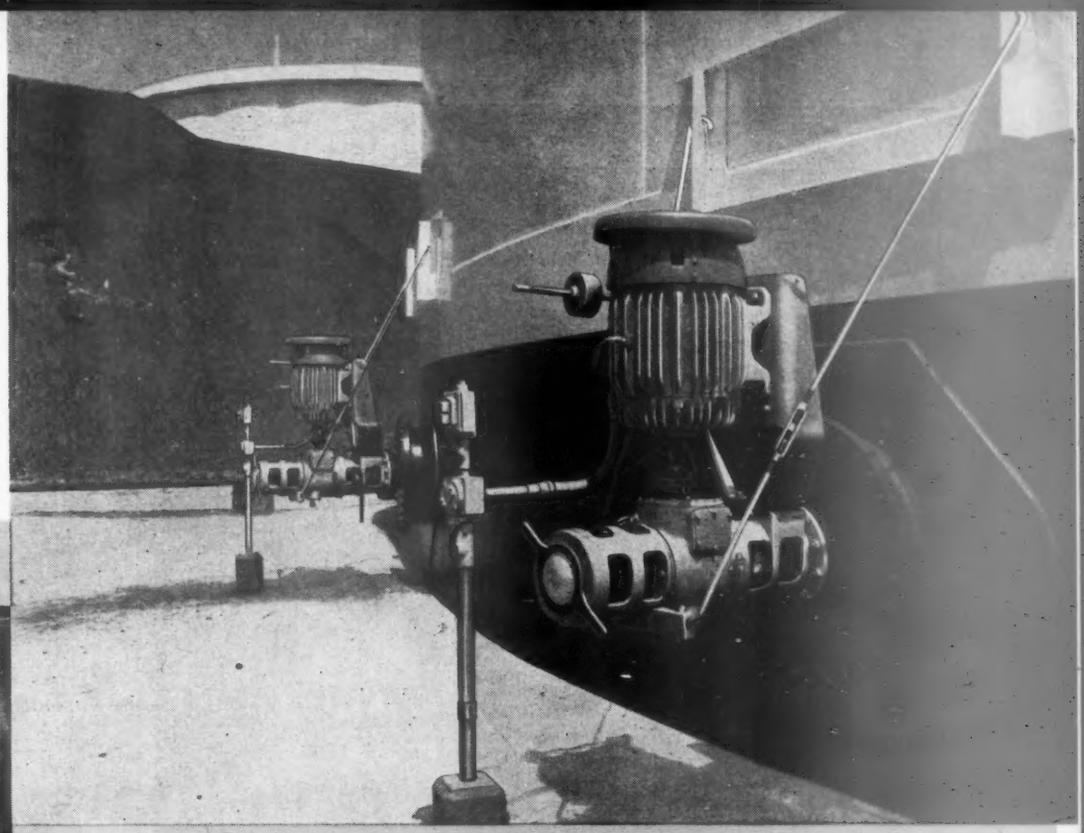

Save $1,000/yr. on tank cleaning

EASIEST MAINTENANCE EVER

New LIGHTNIN Model SE is easier to keep in operation than any other side entering mixer. Here's why:

1. **Positive shutoff seal** permits repacking stuffing box without draining tank. Hand-operated shutoff is easy to get at; eliminates wrenches.

2. **Choice of stuffing boxes** (or maintenance-free mechanical seals) to suit your conditions.

3. **Right-angle drive** eliminates vibration, and gives motor extra protection against ground dust, dirt and moisture.

GET THESE HELPFUL LIGHTNIN CATALOGS

This library of mixing information is yours for the asking. Catalogs contain helpful data on impeller selection; sizing; best type of vessel; valuable installation and operating hints; complete description of LIGHTNIN Mixers.

MIXCO fluid mixing specialists

Have you stopped to consider how much bottom sediment is costing you? Here are a few figures:

In an 80-foot tank, even a 2-foot-deep accumulation of sediment means a loss of almost 2,000 barrels—or about $5,000 per tank turnover.

Then add cleaning cost of as much as $1,000 per tank per year—plus down time while the tank is out of service.

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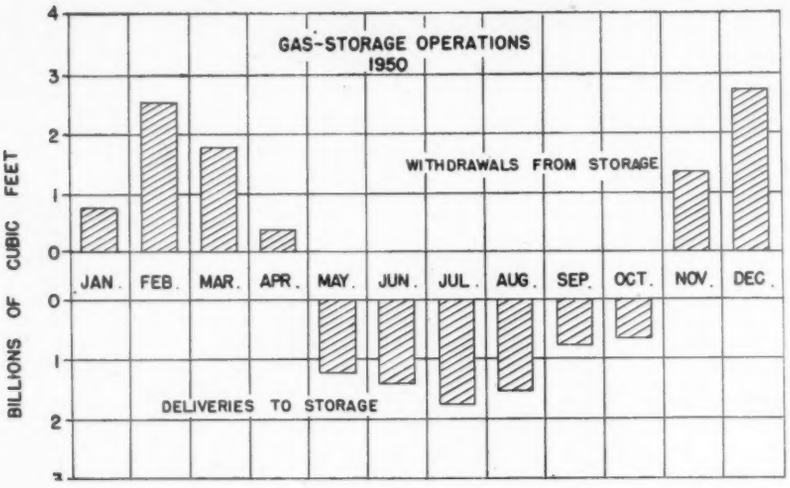

FIG. 1. Typical seasonal cycle of Equitable Gas Company. (After Kornfeld, J. A.)

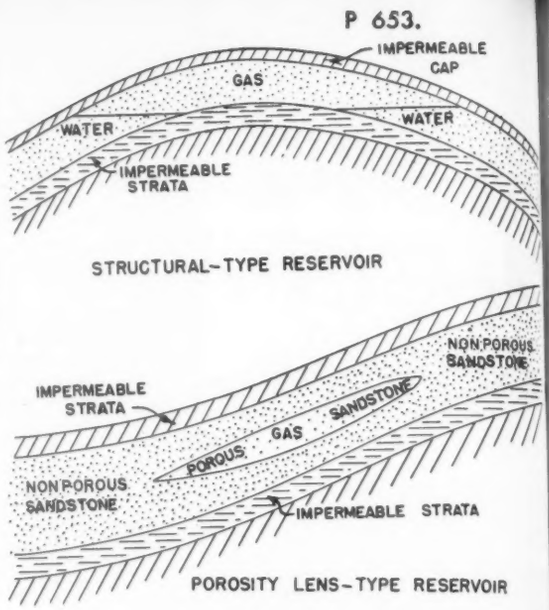

FIG. 2. Types of gas fields used for storage in the Appalachian region. (After Murdy, R. J.)

Underground Storage of Natural Gas

Why and how gas is stored underground — problem in coal-mining areas

HENRY P. WHEELER, JR.* and WILLIAM E. ECKARD†

NATURAL gas was first stored underground in Welland County, Ontario Province, Canada, in 1915.[1] The following year natural gas in the United States was first stored underground successfully in the Zoar field near Buffalo, New York. Only three additional storage fields were in use in the United States in 1930, but by 1940 the number had increased to more than 30, and since that time growth has been more rapid. At least 80 fields, with a combined storage capacity of more than 440 billion cubic feet were being utilized by 1949.[2] In May, 1952, 142 storage projects having a capacity of 915 billion cubic feet were in operation.[3] These fields are distributed from New York to California — from Michigan to Texas. In the Appalachian region alone, there are 101 storage fields with a combined capacity exceeding 526 billion cubic feet.

Why Natural Gas Is Stored

Natural gas is stored in order to be readily available to meet the needs of consumers.

The demand for natural gas is extremely irregular, particularly when a large percentage is distributed to residential customers. The daily average consumption of gas during the winter may be more than twice the daily average in the summer; and on an exceedingly cold day, the peak demand is many times the average summer rate. The demand for natural gas for domestic use on a warm afternoon in the summertime is negligible. Peak demands occur on cold winter mornings when houses are being warmed and breakfasts are being cooked.

It is not practical to operate the gas fields that are the primary source of the natural gas, or the pipelines that transport it, at such variable rates. Gas must be produced at rates low enough that the fields will not be damaged by rapid water encroachment, bypassing of less permeable portions of the formation, excessive losses of reservoir energy, and other conditions. Consequently, natural gas is available from its source at a reasonably constant rate. Also, the capacity of pipe lines that transport the gas to market is limited by their sizes, working pressures, and other factors. Efficient operation of these lines, which vary in length up to about 1800 miles and cost many millions of dollars, requires that they be operated insofar as possible at constant rates at or near capacity.

Storage of gas near the point of consumption is one way to equalize the supply and demand. Natural gas can be produced and transported to the point of storage at a constant rate. When the demand is less than that rate, the excess supply is put into storage, from whence it can be withdrawn later to meet demands in excess of pipe lines and gas-field capacity. As a result, natural gas can be made available to more customers than could otherwise be served. A typical seasonal cycle of injection and withdrawal is shown in Fig. 1.[4]

Storage of gas also provides a supplemental supply to meet emergencies caused by the mechanical failure of pipe lines or other facilities, and better service is assured users of natural gas.

Why Gas Is Stored Underground

Underground storage fields offer two major advantages over other types of natural gas storage. They are bigger and less costly. They cannot replace other types of storage entirely, because there is a definite need for gas holders, steel pipe storage, and other types with less capacity; but, if larger capacity is required, underground storage is the answer, provided of course that a suitable field can be found.

A comparison by F. E. Vandaveer and J. J. Schmidt[5] of estimated capital costs for various types of storage is shown in

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*Petroleum Engineer, U. S. Bureau of Mines, Washington, D. C.

TABLE 1. Comparison of estimated costs for various types of storage.

Type of storage	Cost per M cu ft, dollars
Sphere (80 psi)	227.00
Steel pipe (2240 psi)	207.00
Gas holder (low pressure)	156.00
Steel pipe (1560 psi)	48.00
Natural gas in propane	32.00
Liquefaction	13.00
Salt cavity storage*	1.42
Underground storage (water sand)	0.53
Underground storage (depleted wells–13 fields)	0.02–0.50

* Assuming excavation of 1,000,000 cu ft cavity and disposal of salt brine in deep brine strata. Much less if salt is recovered and sold.

Table 1. The weighted average cost of storing gas in the 13 underground gas storage fields referred to in the table is $0.27 per 1000 cu ft. Average capacity of the 13 fields is almost 5,000,000,000 cu ft, which is also about the average capacity of the 80 fields described by Max Ball in 1949. In recent years, however, the trend has been to larger fields, such as the Oakford storage field near Jeannette, Pennsylvania, of the New York State Natural Gas Corporation. This field, the largest known to the authors, is reported to have a capacity exceeding 100,000,000,000 cu ft. It is difficult to visualize storage of a similar volume of gas above ground.

The Appalachian Region

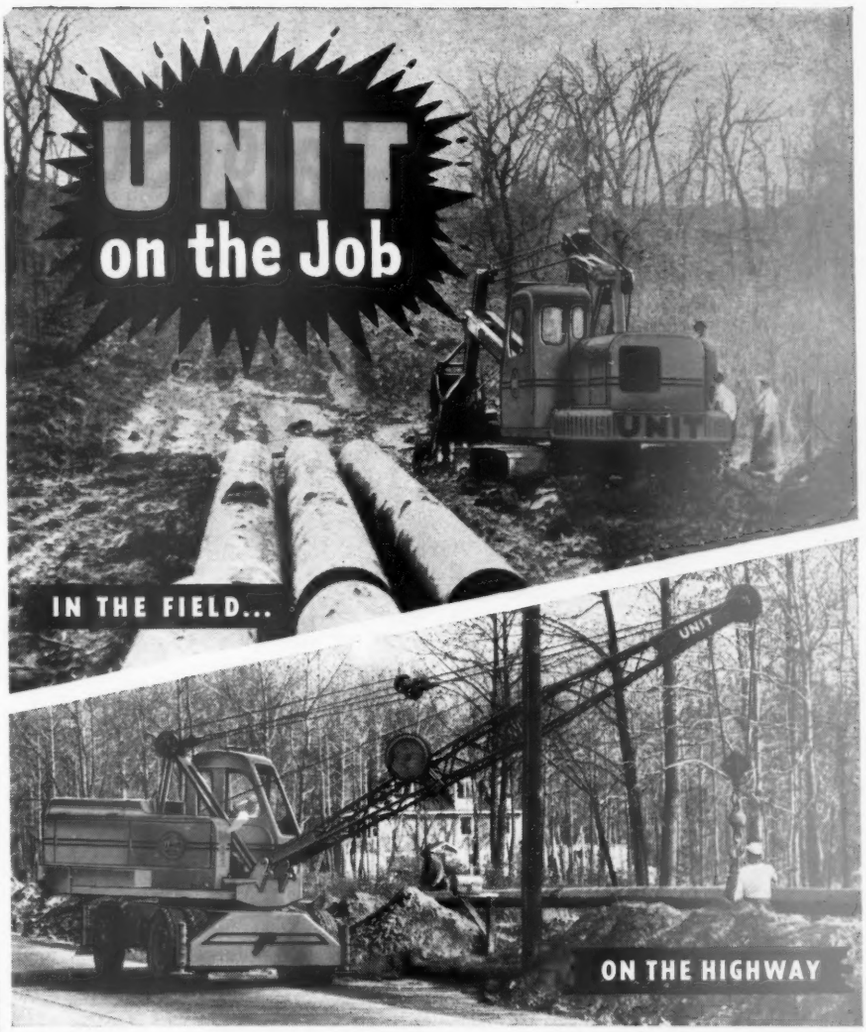
The natural gas industry in the United States originated in the Appalachian region when, in 1820, a well was drilled near a gas seepage in Fredonia, New York, for the express purpose of obtaining a larger flow of natural gas.[6] This well was completed at a depth of 27 ft, and the gas was marketed. Natural gas was utilized in West Virginia in 1841, in Ohio as early as 1860, and in several Pennsylvania towns by 1872. Natural gas was first piped to Pittsburgh in 1883 and has contributed substantially to the industrial growth of the region.

As the industrial centers grew and the population increased, more and more people wanted to use natural gas in their homes. The Appalachian region was able to produce enough gas to meet the growing demand for awhile, but eventually the local supply became inadequate. In 1951, the region consumed about 14½ per cent of all the natural gas consumed in the United States — more than twice as much as it produced — and it has only 2 or 3 per cent of the Nation's gas reserve.

Thus, it is necessary to bring gas into the region through long-distance pipe lines from Louisiana, Texas, and other southwestern states. Storage capacity is needed to permit efficient utilization of these pipe lines, and many suitable exhausted fields are available close to centers of consumption. Through their use, the life of the industry is being prolonged in the Appalachian region, and the inhabitants enjoy an uninterrupted supply of natural gas.

Hazard in Coal-Mining Areas

Concurrently with the growth of underground gas storage, the coal industry has become increasingly aware of the hazards of coal mine explosions result-



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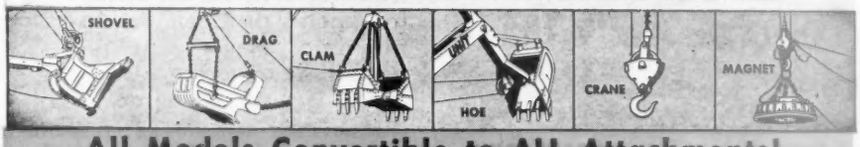

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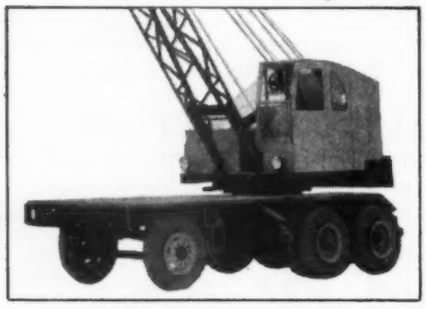

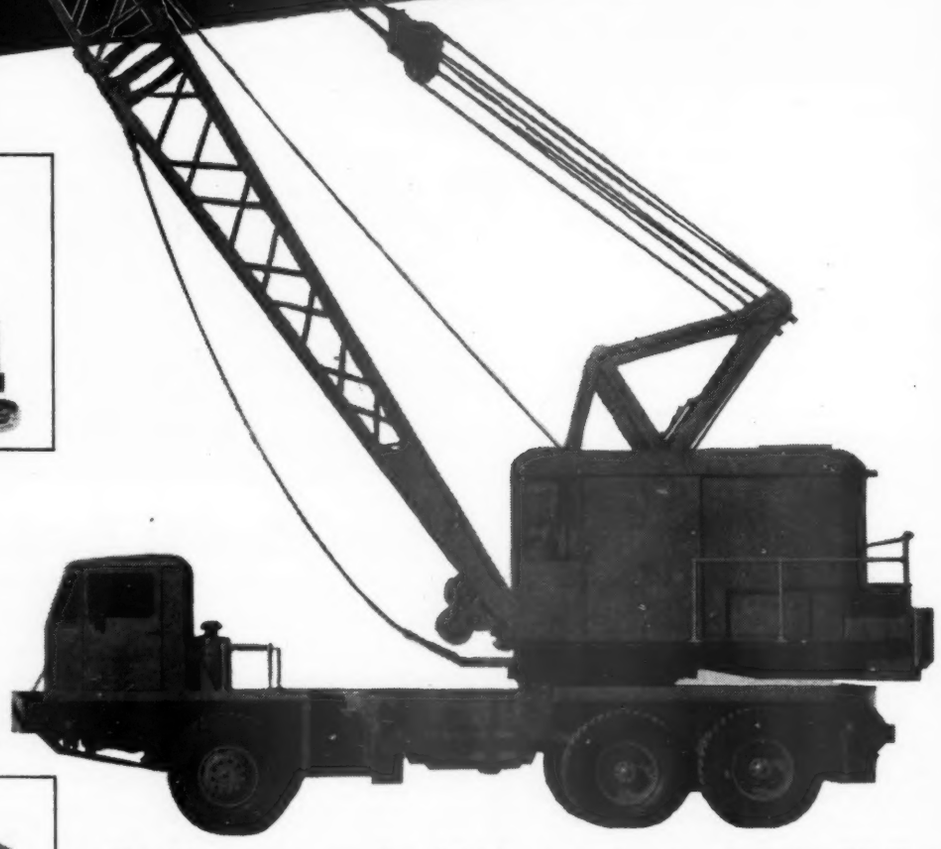

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ing from the ignition of combustible gas mixtures. No more insidious hazard to coal mining exists than emission into the mine workings of firedamp from the surrounding strata, including the coal itself. Firedamp cannot be smelled, tasted, or seen. Usually it is liberated from coal at such low pressure that there is no sound. With rare exceptions, firedamp is methane with only traces of other gases that have no effect on its explosibility. Many hundreds of experiments have shown that the difference in explosibility between firedamp and natural gas is too small to have any significance. The deaths caused by firedamp explosions in coal mines over the hundreds of years of the industry's history are staggering and well nigh unbelievable to persons outside the industry.

It is to be expected that coal-mining men should be alarmed by any possible increase in liberation of explosive gas in their mines. That they should want positive proof that gas stored in the ground cannot enter their mine workings is equally to be expected.

The coal and natural-gas industries are two of the nation's greatest. They compete directly in many fuel markets, and the resultant improvements in production, distribution, and utilization are of great benefit to the general public. The coal industry is justly concerned for the safety of its employees. The gas industry is equally concerned regarding the adequacy of the service that it offers to its customers. Underground storage is vital to the natural gas industry and the many gas consumers in the Appalachian region.

The gas industry does not wish the gas, which it has brought from distant sources and stored, to leak into coal mines or anywhere else. Such leakage would be costly, and the lost gas would not be available to meet the peak demands of the gas consumers.

This report is issued to give information concerning underground gas storage and to point out the authors' conviction that close cooperation between the coal and natural gas industries is necessary whenever gas is stored near active coal mines. Only through such cooperation can the maximum degree of safety protection be afforded. Operating practices in both industries undoubtedly will change over a period of years. Coal will be mined in new areas; gas will be stored in additional fields. Each industry must give some consideration to the possible effects of its expansion upon the other. By so doing, each can progress and contribute more effectively to the overall strength of our nation.

Choosing a Field

The size and type of gas storage required depend upon the purpose for which it is intended.

If a storage field is desired to provide gas during an emergency, such as a pipe line break or other equipment failure, the field need not be large, but it must be capable of producing gas for a short period at a high rate of flow. According to Goodman,[7] a field with a capacity of 200,000,000 to 300,000,000 cu ft of gas, with a delivery adequate to compensate the greatest probable interruption, would be the ideal storage unit for this purpose.

It storage is required to smooth out the seasonal variations in supply and demand, a larger field may be required, depending upon the magnitude of the variations. This type of storage must be capable of producing gas for a sustained period of several months. Goodman has cited Equitable Gas Company Unit No. 3 as an example. It has a capacity of 2,800,000,000 cu ft and an initial delivery rate of 40,200,000 cu ft of gas per day. The larger storage fields are of this type.

Underground storage fields in the United States have been developed from depleted or partly depleted gas fields, oil fields, and abandoned non-commercial gas fields, and also in formerly untested water sands. The old fields have demonstrated their capability of holding gas under pressure at one time; and, unless they have been irreparably damaged through indiscriminate drilling and completion of wells, they may be developed into storage fields. In many cases, the original wells in the field may be used again in the storage operations. Also, the fields may already be connected to existing pipe line facilities.

The usual practice is to search for a suitable storage field as near the market as possible; however, if a major pipe line serves more than one market, storage may be desirable at a point that will enable the field to serve over one market. Thorough study of all depleted gas fields along the transmission lines and within a reasonable distance of the markets may disclose a field suitable for storage. Max Ball has suggested that a large transmission company might afford to go as far as 300 or 400 miles from its markets to obtain a suitable storage field, but most of the present fields are less than 200 miles from the markets they serve. In some cases, two or more small fields may be used if one large enough cannot be found.

If a suitable depleted gas field cannot be found within the area selected for a storage project, it may be necessary to consider some other form of underground storage. In the Doe Run and Maldraugh storage fields in Kentucky, gas is being stored in sands that contained little or no natural gas originally. This idea of storing gas in a water sand has gained considerable popularity in recent months and one such project in Kankakee County, Illinois, with an anticipated cost of $36,000,000 and an estimated capacity of 90,000,000,000 cu ft is under consideration at present.

Gas also may be stored in depleted, partly depleted, or even active oil fields. A good example of this type of storage is the Playa del Rey field in California, which did not contain a gas cap originally, but part of it is being used today for storing natural gas. In the Bammel field, Harris County, Texas, natural gas is being stored in a field that is currently producing liquefied petroleum products through a cycling plant. The stored gas will help to maintain the pressure in the gas-distillate reservoir.

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perhaps some other states, liquefied petroleum gases (butane and propane) are being stored in artifically created caverns in massive salt formations. The cavities are formed by mining or by dissolving the salt in water circulated through wells drilled from the surface. In at least one field, the brine solution displaced by the liquefied petroleum gases is stored in a sand formation, from whence it can be recovered and used to maintain the pressure in the cavern when the liquefied petroleum gases are withdrawn. This method may be applicable to the storage of natural gas. It is not in use now, however, and its possibilities are not known.

Requirements for Gas Storage

It has been stated previously that a storage field should be near the market it serves and large enough and capable of producing gas rapidly enough to meet the demands caused by equipment failures or seasonal variations in temperature. A field may meet all of these requirements, however, and still be useless as a storage field, if it is not gas-tight.

It is self-evident that most depleted gas fields were gas-tight before they were drilled; otherwise, gas could not have accumulated in them. Gas, that tends to migrate upward, has been prevented from so doing by an impermeable rock formation. In some fields the impermeable formation overlies a separate permeable formation, and the gas is trapped in anticilines, domes, and other structures created by folds in the rock strata. In other fields the gas is trapped in formations that have variable permeability, and the impermeable portions of the formation prevent migration of the gas from permeable lenses. Both types of fields are being used for storage in the Appalachian region. Idealized cross-sections showing the relationship of the permeable and impermeable formations in the two types of fields are shown in Fig. 2.[8]

Whether or not a field is gas-tight after it has been depleted depends upon the condition of the wells that exist in the field. In some depleted fields, casing has been pulled from the wells and salvaged, leaving the open hole unprotected. Other wells have been plugged with lead or wooden plugs or with cement; some have merely been filled with dirt and debris.

In addition, there may not be any surface indication of the old wells. Cultivated fields, highways, houses, barns, and other structures may be located directly over them. Unless the history of a depleted field is known and the wells can be found and reconditioned if needed, the risks occasioned by improperly abandoned wells may make the field economically unsuitable for consideration. A storage field must be gas-tight.

The capacity of a field is determined by its areal extent, the thickness of the formation in which gas can be stored, and the effective porosity of the formation. Contrary to some popular opinion, the formation in which gas occurs may not contain large cavities or caverns. In many fields, gas is found in sandstone

resembling that used in constructing buildings; the gas is present in the millions of interstices between the grains of sand. Part of the space is filled with a cementing material, which holds the grains together, and this material may isolate some of the interstices so that there is no passageway between them. Only the interstices that are interconnected are effective in producing gas, and they are the only ones in which gas can be stored. They constitute the effective porosity of the formation. Where information regarding the porosity and thickness of the formation and the areal extent of a field is available, its capacity to store gas at various pressures can be calculated. If these factors are not known, they can be determined by laboratory analysis of rock samples from the formation, electrical well-logging devices, and engineering appraisals.

Another important characteristic is the deliverability of the field. In other words, how rapidly can gas be produced from it, or conversely, how rapidly can gas be injected into it without building up an excessive pressure at the wells? This can be determined in part by the number of wells drilled in the field and the pressure at which gas is stored. The rate at which gas will flow through the formation itself, however, depends directly upon the permeability of the formation — that property that is determined by the size and arrangement of the passageways between interstices. If the passageways will accommodate a high rate of flow with a relatively low pressure drop between interstices, the permeability of the formation is said to be high. The deliverability of wells drilled into such formations is correspondingly high, and fewer wells are required. Not only will each well produce gas at a higher rate, but each will produce gas from a larger surrounding area in a highly permeable formation than it will in a less permeable one.

A field with small capacity and high deliverability is suitable for some purposes; a large field with less deliverability is suitable for others — but a field that is not gas-tight is suitable for none. Thus, ability to hold gas under pressure is the principal requisite of a storage field. If it will leak, the field is useless to a company that wishes to store gas.

Of course, a leaky field also may be hazardous to nearby coal mines; whether or not it is depends on how the gas leaks and where the gas goes. Neither a gas company nor a coal mine owner wants or can afford a leaky storage field.

Developing a Field

If a gas company does not already have the legal right to store gas in an underground formation, that right must be obtained. Many leases were obtained from land owners long before the storage of gas underground was contemplated, and storage rights are not provided therein. Usually, however, land owners are willing to extend these rights and thus prolong the receipt of income from a source that otherwise would be depleted.

In Illinois, Oklahoma, Kansas, and New Jersey, the benefit of underground gas storage to the general public has been recognized, and laws have been passed extending the right of eminent domain to underground gas-storage fields. Thus, storage rights can be obtained by condemnation proceedings if necessary to serve the best interests of the public; however, such proceedings rarely are employed.

Finding and Reconditioning Old Wells

The finding and reconditioning of old wells in a depleted field are vital factors in determining whether or not it will be successful in its new role. An undiscovered or improperly completed well might leak gas from the storage field and cause a loss to the gas company as well as a hazard to nearby coal mines. Consequently, these operations receive thorough consideration and study by geologists, petroleum and natural gas engineers, and other skilled personnel of the gas companies. Reworking old wells is costly, but when the success or failure of a multimillion dollar project is at stake, no practice short of the best that is known can be afforded.

Locating abandoned wells is sometimes difficult, when little or no surface trace of the wells remains. Old maps, well-log files, and other old records may provide valuable clues. Royalty owners, lease employees, retired drillers, and other old inhabitants of an area usually are sources of helpful information. Commercial pipe detectors, wartime mine detectors, dip needles, and magnetic compasses are particularly useful. With this equipment, engineers can find the exact location of many abandoned wells and the approximate location of others. Some wells can be found only by extensive excavation with a bulldozer, and gas companies have dug up several acres of land in some instances to find abandoned wells; the gas company's engineers must be satisfied that all of the wells in a field have been found before they proceed to develop it for gas storage.

After the wells are found, their mechanical condition is determined; if necessary, they are plugged or reconditioned. This is a costly endeavor but is fully justified. A well in an active gas field must be completed to last for the life of the field, whereas a well in a gas-storage field must be completed to last indefinitely.

Completion practices vary in the Appalachian region according to conditions encountered in the wells. Fig. 3 illustrates typical casing and cementing methods used by one company.[9] Both the surface and production strings of casing are cemented to the surface, providing a double string of cemented pipe through coal measures. This method affords excellent protection against the loss of gas from storage into coal measures, water sands, or elsewhere. Completion methods used by other companies vary somewhat from that shown in

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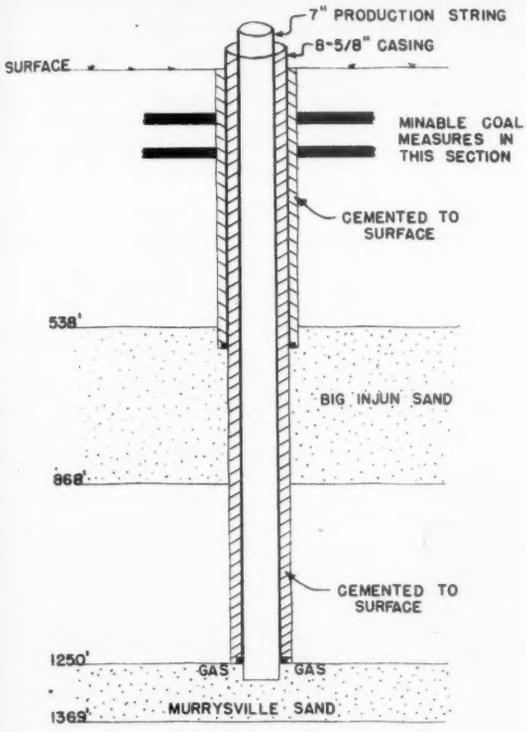

FIG .3. A method of cementing casing in a gas well. (After Murdy, R. J.)

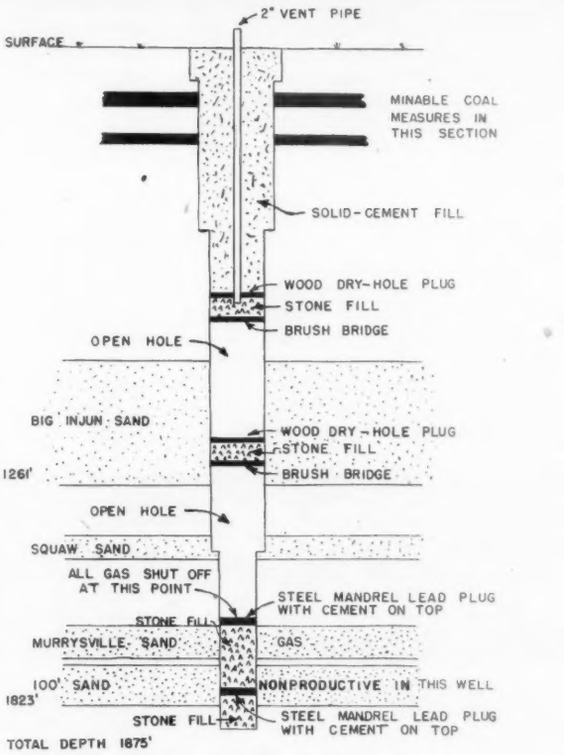

FIG. 4. A method of plugging a gas well for abandonment. (After Murdy, R. J.)

Fig. 3, but all must protect against leakage.

The problems of drilling and completing oil and gas wells through coal beds are not new. The director of the Bureau of Mines called a meeting of coal operators and oil and gas operators in 1913 to discuss precautionary methods to be taken when drilling oil or gas wells through workable coal beds.[10-11] Later, in April, 1928, the American Institute of Mining and Metallurgical Engineers made a report on the subect. In November 1929, the Bureau of Mines issued an Information Circular,[12] describing, in part, regulations governing the drilling of oil or gas wells through workable coal beds in several states, notably West Virginia. It can be seen, therefore, that the subject has been exposed to much discussion by competent authorities, and regulation by several states. Pesent-day drilling and completion practices are the results of many years of experience.

Plugging wells that are unsuitable for one reason or another for use in a storage field is a kind of reconditioning. As a matter of fact, some wells that are ultimately plugged require considerable reconditioning — redrilling and cleaning out — before they can be plugged. Fig. 4 illustrates a method by which one gas well was plugged for abandonment[9]; however, this is not the only way that a well can be plugged effectively, and it must not be considered a standard for the region.

New Construction

Although finding a suitable field and reconditioning old wells are primary requisites of an underground gas storage project, they are not the only factors to be considered. Pipe lines must be built, in many instances, to serve as connecting links between the storage field and the distribution system. Compressor stations to boost the gas pressure are frequently needed. Gas dehydration plants may be required to remove water vapor from the gas and thus prevent formation of hydrates in the pipe lines. Also, additional wells usually are needed to provide adequate deliverability of gas during peak loads. All these factors add to the cost of the project. The gas industry cannot afford these expenditures without reasonable assurance that the storage will be gas-tight.

The drilling of new wells in the vicinity of coal mines is of vital concern to coal operators. In drilling these wells, the gas companies are not restricted, as they might be in reconditioning old wells, as to the size of the hole drilled and the resultant casing programs. New wells in gas storage fields embody all of the best practices and materials known to the industry.

Storage Pressures

In general, gas is stored underground in the Appalachian region at pressures that do not exceed the original pressure of the field in which it is stored. This practice is based on the theory that the field was filled by nature to that pressure and thus has been proved to be gas-tight at that pressure.

Some gas companies are storing gas at pressures that exceed the discovery pressure, however, and this practice has caused alarm among coal operators who fear that the extra pressure might open new passageways in the underground formation through which gas might escape from storage into their coal mines, with disastrous results.

These fears are understandable. Some underground storage fields resemble domes, with a water seal at the edge. It is possible that enough gas could be forced into such a dome to depress the water, break the seal, and allow gas to migrate into previously barren formations. Also, it is conceivable that enough pressure might be exerted in shallow fields to actually lift the overlying strata and create new passageways within the formation.

No group is better aware of these possibilities than the gas companies themselves. As pointed out previously, they can ill afford to lose gas from storage. These companies maintain staffs of trained engineers and geologists to delineate the fields. Edge wells are drilled to detect the presence of gas. Movement of the water level in each field is carefully watched. Also, engineers can calculate the pressures required to lift the overburden at various depths.

Gas Accounting in Storage Fields

The proof of the pudding is in the eating; and the proof of a gas storage field is its ability to store gas in times of low demand and make it available to meet the peaks. In many respects, a storage field is similar to a bank, and the gas companies expect to get out as much gas as they put in. Moreover, a company must know how much gas it has in storage at any particular time. Thus, it is necessary to account for the gas as it is injected and withdrawn.

XUM

Accurate gas-measurement records of the field's operation are kept. They enable the operator to calculate the volume of gas injected or withdrawn per pound of change in pressure and thus define a standard of performance that can be compared with the performance of the field at any date. This index of performance is known as the "volume-per-pound" relationship. Because of the pressure gradients set up within the formation when gas is injected or withdrawn, the relationship seldom is a straight line, and the withdrawal curve usually lags behind the injection curve.

In spite of the best efforts of the gas companies to account for the stored gas, it must be recognized that orifice meters and other measuring devices are not accurate enough to provide an absolute check against the loss of gas in small quantities, but large enough to create an explosive hazard in a coal mine. It behooves the coal operators, therefore, to be ever on the alert for gas occurrences from whatever source.

Conclusions

The storage of natural gas underground in coal-mining areas is necessary if the inhabitants of those areas are to enjoy continued use of natural gas in their homes; however, storage fields must be developed with due consideration of the rights and safety of the coal industry.

The authors believe that the only satisfactory solution is complete cooperation between the two industries and their mutual enlightenment through free exchange of information. No doubt, questions will be asked to which no completely satisfactory answer can be given because knowledge is incomplete. When this happens, a joint and vigorous effort should be made to fill in the gaps in information.

The competitive relationship between the two industries must not become a stumbling block in the way of safety and public interest; the natural growth of both should be encouraged.

Acknowledgments

This report was prepared under the general supervision of R. A. Cattell, chief, Petroleum and Natural Gas Branch, Bureau of Mines, Washington, D. C.; H. P. Greenwald, Regional Director, Bureau of Mines Region VIII, Pittsburgh, Pennsylvania; and S. S. Taylor, supervising engineer, Bureau of Mines Petroleum Field Office, Franklin, Pennsylvania.

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The assistance and cooperation of the gas companies in the Appalachian Region, through the American Petroleum Institute Eastern District Study Committee on Natural Gas Operating Practices (Underground Storage), J. G. Montgomery, Jr., chairman, and the American Gas Association, Natural Gas Department, Committee on Underground Storage, Fenton H. Finn, chairman, is acknowledged gratefully. John C. Goodman of Equitable Gas Company was particularly helpful in supplying recent statistics on underground storage.

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* * *

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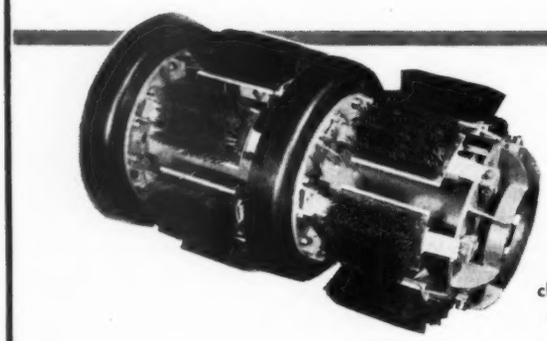

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Natural Gas Reserves Increase Despite Heavy Production

Proved recoverable natural gas reserves in the United States on December 31, 1952, totaled 199.7 trillion cubic feet, an increase of 5.9 trillion cubic feet over reserves of 193.8 trillion cubic feet a year earlier, it is announced in a joint report of the Committee on Reserves of the American Gas Association and the American Petroleum Institute. These reserves achieved a new record high level after an all-time high production of 8.6 trillion cubic feet of natural gas in 1951.

The AGA Committee on Natural Gas Reserves estimated proved recoverable reserves of natural gas liquids on December 31, 1952, also had risen to a record level of almost 5 billion barrels. This compares with a previous high of 4.72 billion barrels at the end of 1951. This increase was registered despite a record production of 285,000,000 bbl of natural gas liquids last year.

Crude oil reserves on December 31, 1952, totaled approximately 28 billion barrels, compared with 27.47 billion barrels at the end of 1951. The total estimated liquid hydrocarbon reserves on December 31, 1952, were 32.96 billion barrels, compared with 32.19 billion barrels a year earlier.

Discovery of 5.4 trillion cubic feet of new natural gas reserves in 1952 as compared with 3 trillion of reserves in new fields brought in during 1951, emphasizes the important increase in exploration activities resulting from the ever-increasing demand for natural gas. Further exploration and drilling in existing fields added another 8.9 trillion cubic feet to the nation's proved recoverable reserves of natural gas. Nearly 199 billion cubic feet of natural gas were added to estimated reserves in underground storage at the end of 1952. Proved reserves of natural gas and natural gas liquids made substantial gains.

Natural Gas Transmission Safety Association met in Memphis Tennessee, recently. Attending were: Seated, Stanley Owens, R. M. Garrigus, safety engineer, Tennessee Gas; R. L. Matheson, assistant personnel director, Panhandle Eastern Pipe Line; J. N. Jacobsen, safety engineer, Natural Gas Pipeline; second row, Lester Lind, safety director, Michigan-Wisconsin Pipe Line; R. E. Hill, safety and training director, Cities Service; Robert Mattingly, safety engineer, Texas Gas Transmission; Marvin Travis, safety engineer, Northern Natural; John L. Smith; W. O. Lape, supervisor of training and safety, Texas Gas Transmission; third row, Boyd Armour, assistant safety engineer, Tennessee Gas; P. A. Campbell, safety director, Colorado Interstate Gas; William Angus, assistant safety director, and Superintendent Newberry, El Paso Natural Gas; E. L. Myers, safety engineer, Panhandle Eastern; D. E. Baxter, and Les Gibson, safety engineer, Texas-Illinois.

Pipe Line Companies Hold Semi-Annual Safety Meeting

Semi-annual meeting of the Natural Gas Transmission Safety Association was held at the Peabody Hotel in Memphis, Tennessee, recently.

R. L. "Dick" Matheson was acting chairman for the first day in the absence of Ray Garrigus, who was not present until the second day due to pressing company business. At this meeting each company had its safety representatives attending as well as an operating supervisor. Transcontinental was represented by Stanley Owens, director of safety; John L. Smith, safety engineer; and D. E. Baxter, Compressor Division II superintendent.

A comparison of employee injury frequency and severity rates for the year 1952 was made among member companies, along with a comparison of vehicle accident rates expressed in miles driven per accident for the year 1952.

Stanely Owens of Transcontinental spoke on "Pre-employment Physical Examination Forms, their Use and Value to the Safety Program."

A discussion of "What Supervisors Expect From Safety Engineers" was presented by W. A. Johnson, Jr., superintendent of pipe line, Texas Gas Company, Owensburg, Kentucky.

John L. Smith of Transcontinental addressed the group on "Safe Driving Habits for Industrial Drivers."

A training program for safety meeting chairmen was presented by Boyd Armour, assistant safety engineer, Tennessee Gas Transmission Company.

Shreveport, Louisiana, office building of Texas Eastern Transmission Corporation.

Texas Eastern Officially Opens New Building

Texas Eastern Transmission Corporation officially opened its new 14-story office building in downtown Shreveport, Louisiana, on February 28. No formal ceremonies were held but employees, their families, and the general public of the Shreveport area were invited to visit the building between 11 a. m. and 7 p. m. and go through the offices.

Known as The Texas Eastern Building, the completely air conditioned structure has about 200,000 sq ft of office space, somewhat more than half of which is used for general offices by Texas Eastern; remainder is leased.

Rapid Gas Expansion Shown in FPC Report

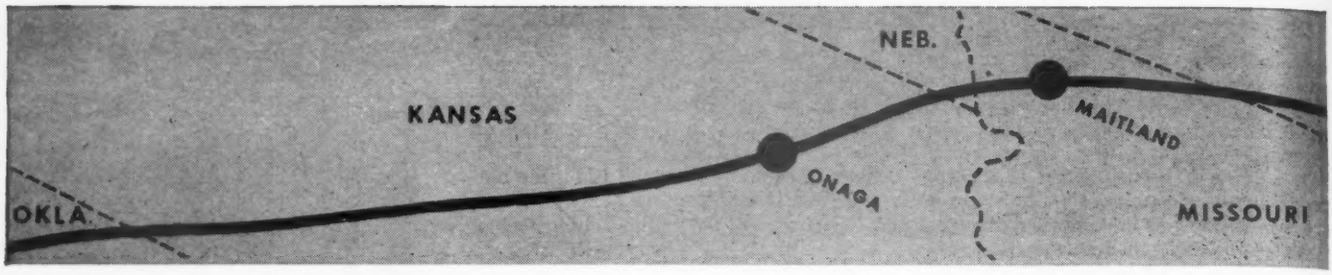
The phenomenal growth of both natural gas and electric power industries keynotes the Thirty-second Annual Report issued by the Federal Power Commission.

As the lengthening system of natural gas pipe lines pushed into new areas across the United States, the Federal Power Commission considered 161 applications, and, of this number, issued 136 certificates for the construction and operation of transmission facilities. Certificates of public convenience and necessity approved during 1952 authorized installation of 3378 miles of pipe line and 539,510 compressor horsepower, the commission reports. Cost of this construction was $322,000,000.

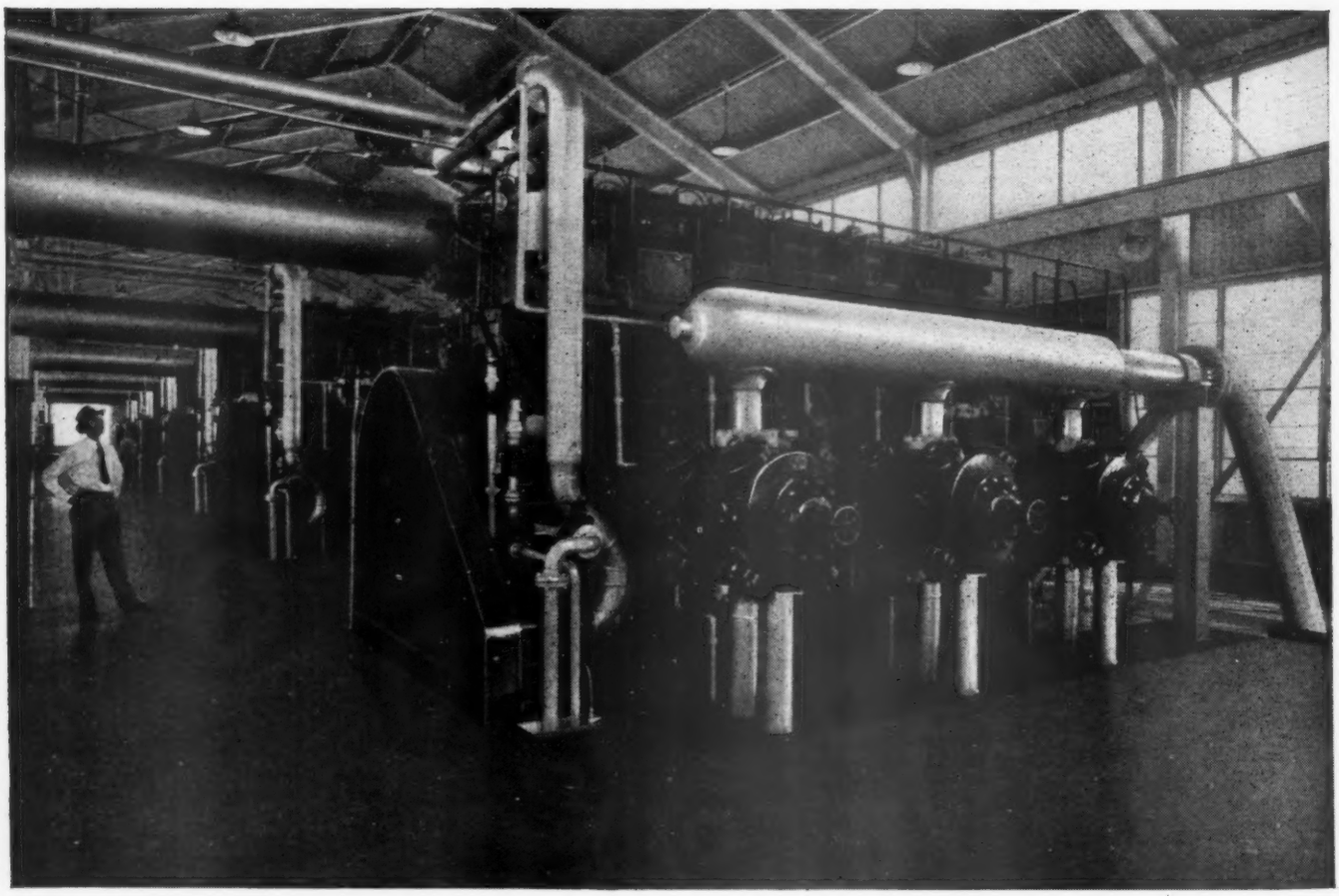
Annual report further notes that during the decade between February, 1952, and June, 1952, the agency issued 863 certificates involving construction and operation of $3,165,000,000 in pipe lines, compressor horsepower and auxiliary facilities. This figure represents a 164-per cent increase in gas plant investment since Federal regulation began in 1938.

Total estimated investment in gas plant facilities authorized or pending at the end of fiscal 1952 amounted to $3,945,000,000, which is 204 per cent over the 1938 total gas plant investment.

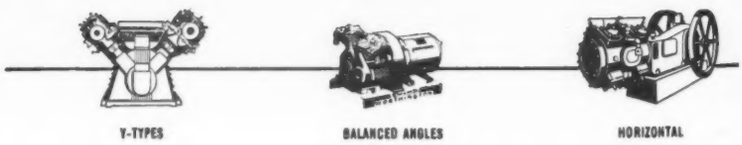
Another fact is that during 1950 alone, 2543 billion cubic feet were piped across the nation and use is increasing.



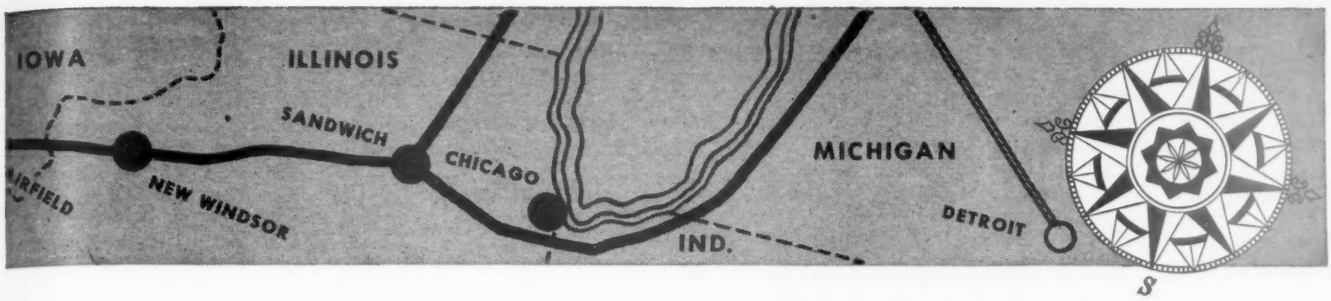
Michigan-Wisconsin Operates 27 Worthington



Six Worthington UTC Engine-Compressors, each rated at 1,400 hp, 320 rpm. Installation is at New Windsor, Illinois, station No. 9 of the Michigan-Wisconsin Pipe Line Company. Each engine uses Worthington's scientifically developed uniflo thru-scavenging system.



NO OTHER COMPRESSOR WILL



Pipe Line Company Engine-Compressors

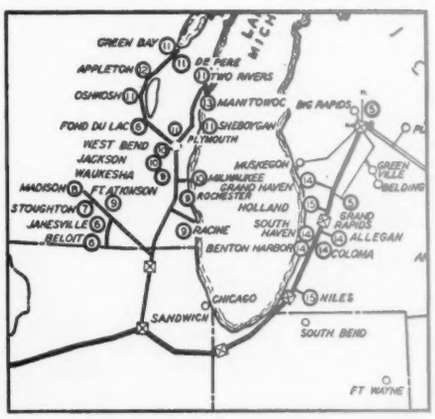
Big 1,400-hp UTC's move gas through 3 stations along line

The pipeline that brings natural gas to Detroit from northern Texas also feeds most of Wisconsin and eastern Michigan.

Three of the compressor stations are equipped with Worthington UTC gas-engine compressors—eighteen in all, a total of 25,000 horsepower. The sure-fire, highly efficient performance of these units, and many others like them, is your best evidence of the advantages offered by Worthington's uniflo timed-scavenging system that thoroughly removes burned gases.

But the UTC has many uses other than as a pipeline gas-engine compressor. It can perform with equally high efficiency on oil wells for pressure maintenance . . . in oil refineries for solvent extraction, vapor recovery, recycling and stabilization of gases . . . in natural gasoline plants . . . in petrochemical processing of products made from natural gas under pressure . . . and in many refrigeration applications.

Built in sizes from 1,000 to 2,000 hp, the uniflo UTC will improve *your* process, if it requires gas compression. All you need is a suitable gas for fuel. Your nearest Worthington district office can give you full information, or you may write directly to Worthington Corporation, Engine Division, Buffalo, New York.



Delivering Gas to Industrial Detroit, the Michigan-Wisconsin Pipe Line Company draws from the Texas Panhandle, with many utilities buying right off the line en route. Operating at its maximum capacity of 343 MMCF per day, this line is one of the few operating at the same capacity throughout the year. A tremendous storage field near Big Rapids, acting as a reservoir for the whole area, takes care of winter demands, absorbs summer pipeline surplus. To keep the gas moving, the pipeline uses Worthington UTC engine-compressors in 3 of its stations. Also used at two other stations are nine Worthington twin-tandem horizontal gas-engine compressors totaling 14,400 hp.

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PAD Allocates 223,308 Tons Steel for Gas Lines

Ten major natural gas pipe line projects have been given priorities assistance by the Petroleum Administration for Defense for the purchase of 140,425 tons of line pipe for the second quarter of 1953, Deputy Petroleum Administrator J. Ed Warren announces. Total estimated construction cost of the ten projects is $348,346,118.

In addition, 82,883 tons of pipe have been allocated to 525 smaller projects, including gathering lines, distribution lines, other facilities, and MRO (maintenance, repair, and operations).

Total pipe allocated to date for gas lines for the quarter is 223,308 tons.

Six of the major projects are getting steel for the first time:

1. El Paso Natural Gas Company's project for transmitting an additional 400,000,000 cu ft daily to markets in New Mexico, Arizona, and California.

2. Pacific Gas and Electric Company's project for looping sections of their 34-in. line from the Colorado River westward to California markets.

3. Utah Natural Gas Company's gathering and transmission pipe line facilities from Clear Creek Field to Provo.

4. East Ohio Gas Company's project for looping an existing 20-in. line between Toledo and Cleveland, Ohio.

5. Chicago District Pipeline Company's project for looping transmission lines from Joliet to Chicago.

6. Houston Pipe Line Company's looping part of present lines from two Texas producing fields to the Houston market area.

Four other major projects have been given allocations of pipe in earlier quarters:

1. Looping and extension of Southern Natural Gas Company's system for additional supplies to its entire market area.

2. Looping of part of existing system of Tennessee Gas Transmission to provide additional supplies to its market area.

3. Ohio Fuel Gas Company's compressors, pipe lines, and facilities for expansion of their underground storage.

4. New York State Natural Gas Corporation's transmission line from Cameron County, Pennsylvania, to Armstrong, Pennsylvania.

Details of the major projects given priorities assistance for the second quarter of 1953 are the following:

	Estimated cost	Estimated completion date	Capacity, cu ft/day	2Q53 line pipe required, tons
El Paso Natural Gas	$88,140,274	1Q54	400,000,000	5,000
Pacific Gas and Electric	22,335,000	1Q54	150,000,000	23,423
Utah Natural Gas	4,000,000	3Q53	50,000,000	7,081
East Ohio Gas	9,160,970	4Q53	75,000,000	11,317
New York State Natural Gas	4,487,484	3Q53	77,000,000	9,183
Ohio Fuel Gas	4,531,200	2Q53	138,000,000	5,983
Chicago District Pipeline	4,550,000	4Q54	495,500,000	6,201
Houston Pipe Line	2,710,000	1Q54	100,000,000	4,000
Southern Natural Gas	77,675,600	1954	350,000,000	36,479
Tennessee Gas Transmission	130,755,590	4Q53	405,000,000	31,758
Total major projects	348,346,118		2,240,000,000	140,425
Other projects				82,883
Total line pipe allocations to date for second quarter 1953.				223,308

Contract Awarded for Evangeline System

A contract has been awarded to Panama-Williams Company, Houston, to construct a 16-in. diam refined products pipe line between Port Arthur, Texas, and Baton Rouge, Louisiana, known as the Evangeline Products System, it was announced by J. W. Emison, president, and R. B. McLaughlin, chairman of the board of The Texas Pipe Line Company.

Work is due to begin about April 1 on the products pipe line, which will be approximately 194 miles in length.

The system will be owned on an undivided interest basis by The Texas Pipe Line Company, 40 per cent; Gulf Refining Company, 40 per cent, and Sinclair Pipe Line Company, 20 per cent. Texas Pipe Line Company will have charge of constructing the products transmission system.

The system will transport gasoline, kerosine, and fuel oil, and the initial capacity will be 96,000 bbl a day.

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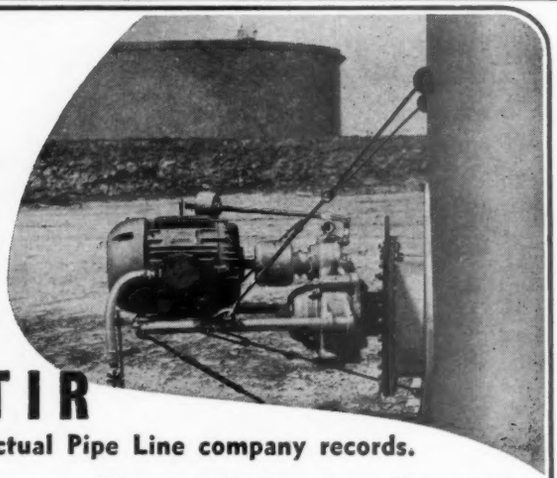

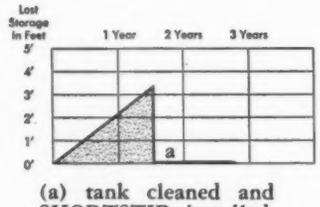

(a) tank cleaned and SHORTSTIR installed.

These records show that sediment had accumulated, in some cases, at the rate of over 2 feet per year. SEE GRAPH.

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Two Projects Contracted By Interstate Pipe Line

Interstate Oil Pipe Line Company announces the letting of a contract to River Construction Corporation, Fort Worth, for two related crude oil trunk line projects.

One project is the construction of 22 miles of 18-in. crude oil trunk line from the Louisiana-Texas state line to the site of Finney pump station, which is approximately 10 miles southeast of Shreveport in Caddo Parish, Louisiana.

The second is the construction of 28 miles of 22-in. trunk line from Finney station site south and east to a point approximately 5 miles northwest of Coushatta, in Red River Parish, Louisiana.

Construction of the 18-in. line was scheduled to begin by April 1. Upon the completion of the 18-in. line, the contractor will begin construction of the 22-in. line. Completion of both projects is expected on or before June 15 of this year.

Both projects are a part of Interstate's modernization and expansion program for the company's Shreveport-Baton Rouge trunk line system, the overall plans for which were announced last year.

Both projects will be carried out under the general supervision of J. B. Barnett, district superintendent of Interstate's Shreveport district, headquarters of which are at the company's Moore station near Shreveport.

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5000-7000 mc. frequency range means high-gain, interference free signals. Philco's "Carrier Control"—the exclusive feed-back principle—minimizes carrier distortion. And all Philco systems are designed to provide a thirty-decibel safety margin to combat most severe fading conditions. Only Philco microwave gives sure communications and complete control.

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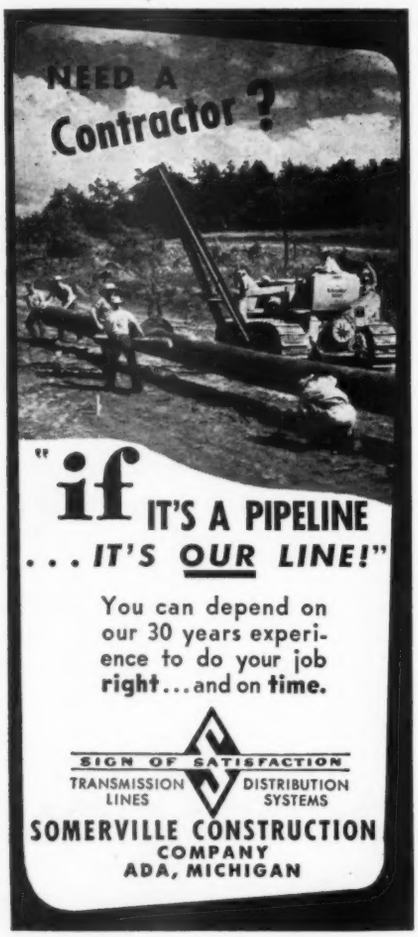
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Pipeliners attending the Corrosion Short Course held in Tulsa, Oklahoma, recently: T. M. Ragland, Phillips; Marshall Parker, Cormit Engineering; F. M. Hieronymus, Barrett Division; L. F. Heverly, Great Lakes Pipe Line; F. M. Cloninger, Texas Pipe Line; T. L. Canfield, Consolidated Gas. No shown, Y. W. Titterington, Pipeline Anode Corporation.

Large Attendance at Fourth Corrosion Course

More than 200 pipeliners from all sections of the U. S. attended the fourth annual 3-day Tulsa, Oklahoma, short course for practical control of pipe line corrosion which closed March 6 with field demonstrations and a question-and-answer session. Sponsored by the National Association of Corrosion Engineers as in the past, the school attracted several pipeliners from Ontario and Alberta, Canada, and one from Monterrey, Mexico. Attendance has grown since the course was begun.

In the opinion of W. A. Hutchison, Sinclair Pipe Line Company engineer in charge of the short course, the practical aspect of corrosion control was clearly emphasized by each instructor in explaining the latest methods, materials and equipments used by the industry.

Tennessee Gas Begins 1953 Construction Program

Tennessee Gas Transmission Company has launched a 1953 construction program to enlarge its natural gas pipe line system, it is announced at the firm's headquarters in Houston, Texas, by Charles S. Coates, senior vice president.

Program includes laying approximately 369 miles of pipe line in Texas, Louisiana, Tennessee, Kentucky, and Pennsylvania, enlarging two of its existing compressor stations, and completing construction of a new 26th station.

The 369 miles of pipe line includes 237 miles of loop line to be built parallel to sections of the existing system, and a new 132-mile line 26 in. in diam to begin at the company's compressor station near Mercer, Pennsylvania, and extend northeast to the Hebron field in Potter County, Pennsylvania, where construction of storage facilities has been authorized by the Federal Power Commission.

W. C. McGee, Jr., vice president and general superintendent of operations, said construction of the first two sections of loop pipe line began in late January and February in south Texas. As warmer weather arrives farther north along the system, construction will get underway on additional projects of the program, he said, with completion of the work anticipated by August 1.

Other details of the construction program were given by E. S. Murray, company chief engineer, as follows:

Texas: Three sections of loop pipe line will be laid in the state. A 43-mile length of line 26 in. in diameter from near Edinburg to near Falfurrias, and a 23-mile section of 30-in. line from near Sinton to near Refugio, are both under construction. Another section of 30-in. pipe line about 28 miles long will be laid from near Edna to about 10 miles southeast of East Bernard.

Louisiana: A 22-mile, 30-in. section of line to be laid parallel to the system from near Natchitoches to near Goldonna. Completion of a new compressor station near Kinder, where installation of five engines with 1320 hp each, for a total of 6600 hp, is in an advanced stage.

Tennessee: An 18-mile, 30-in. stretch of loop line will be laid from south of Bolivar to near Selmer, and a 47-mile, 30-in. line from a point about 20 miles north of Nashville to near Bowling Green.

Kentucky: A 35-mile, 30-in. line from near Campbellsville to near Danville, and a 21-mile, 26-in. line from near Carter to the Ohio River.

Ohio: Two 1320-hp compressor engines will be installed at the company's Station 214 near Carrollton.

Pennsylvania: A 132-mile, 24-in. pipe line will be laid from near Mercer to the Hebron field, Potter County, and two 1100-hp compressor engines will be installed at the company's compressor station 219, near Mercer.

Six Pacific-Western gear drives were selected for the Junction Station of the Union Oil Company's Northern Division pipe-line station. Each unit reduces 720 rpm at 250 hp from Diesel engine drive to power pump delivering pipe-line crude at 1000 psi.

In this station, as in many other oil and gas pumping stations throughout the United States, Pacific-Western gear drives provide unfaltering service.

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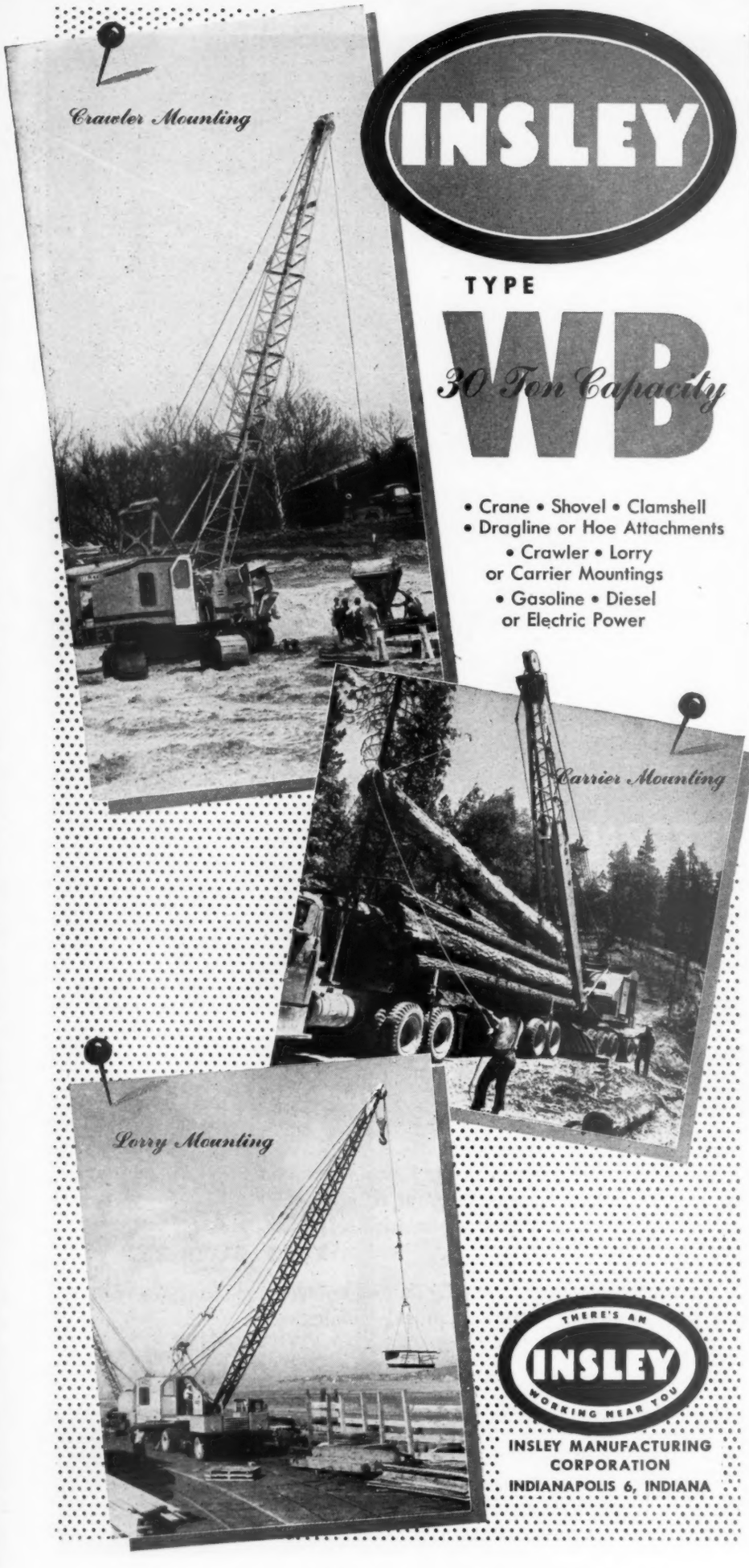

Pipe Line News

Members of AGA 1953 PAR Committee Named

James F. Oates, Jr., chairman, The Peoples Gas Light and Coke Company, Chicago, is chairman of the 1953 Promotion, Advertising and Research (PAR) Committee of the American Gas Association. Stuart M. Crocker, chairman of the board, The Columbia Gas System, Inc., New York, and C. H. Zachry, president, Southern Union Gas Company, Dallas, are vice chairmen.

The PAR Committee is responsible for raising and disbursing more than $2,000,000 a year of voluntary subscriptions from gas transmission and distribution companies.

Other members of the 1953 PAR Committee are: N. B. Bertolette, president, Hartford Gas Company, Hartford, Connecticut; Charles P. Crane, president, Consolidated Gas Electric Light and Power Company, Baltimore; R. E. Crawford, president, Minnesota Valley Natural Gas Company, Minneapolis; Hugh Cuthrell, president and chairman of the board, The Brooklyn Union Gas Company; H. Reid Derrick, vice president, Alabama Gas Corporation, Birmingham; Henry Fink, president, American Natural Gas Company, Detroit, and John C. Flanagan, vice president and general manager, United Gas Corporation, Houston.

Also appointed to the PAR Committee were: Ralph L. Fletcher, president, Providence Gas Company, Providence, Rhode Island; C. H. Gueffroy, president, Portland Gas and Coke Company, Portland, Oregon; J. K. Horton, president, Pacific Public Service Company, San Francisco; Wister H. Ligon, president, Nashville Gas Company, Nashville, Tennessee, and Donald C. Luce, vice president, Public Service Electric Gas Company, Newark, New Jersey.

Also J. F. Merriam, president, Northern Natural Gas, Omaha; Curtis Morris, vice president, Transcontinental Gas Pipe Line, Houston; Dean H. Mitchell, president, Northern Indiana Public Service, Hammond, Indiana; Karl B. Nagler, vice president, The Peoples Gas Light and Coke, Chicago; Robert W. Otto, president, Laclede Gas, St. Louis; Jules D. Roberts, vice president, Mountain Fuel Supply, Salt Lake City; J. French Robinson, president, Consolidated Natural Gas, New York; W. T. Stevenson, president, Texas Gas Transmission, Owensboro, Kentucky, and Thomas Weir, vice president and general manager, Union Gas Company of Canada, Ltd., Chatham, Ontario.

Ex officio members of the PAR committee are Frank C. Smith, president, Houston Natural Gas, and president, AGA; E. H. Eaker, president, Boston Consolidated Gas, and vice president, AGA; F. M. Banks, president and general manager, Southern California Gas Company, Los Angeles, vice president, AGA; E. F. Barrett, president, Long Island Lighting Company, Mineola, New York, treasurer, AGA, and Frank H. Lerch, Jr., chairman of the board, Consolidated Natural Gas. J. W. West, Jr., assistant managing director, AGA, is secretary of the PAR Committee.

SGA Attracting Heaviest Advance Registration in History

Southern Gas Association's 45th annual convention at New Orleans, Louisiana, May 11 to 13, is attracting the heaviest advance registration in the organization's history. Indications are that more than 1800 delegates, visitors, and ladies will be on hand for the three days of programs arranged to interest all branches of the industry.

Senator Everett M. Dirksen of Illinois has accepted an invitation to speak at Wednesday morning's general session.

On the program for Tuesday morning's general session is Dr. Alfred P. Haake of Park Ridge, Illinois, economist and consultant to General Motors.

Convention headquarters will be the Jung Hotel, where all sessions will be held except those of the sales section, which will be at the Roosevelt Hotel.

Because of the record-shattering attendance the housing committee, headed by C. B. Wilson of New Orleans Public Service, Inc., has its hands full to see that delegates and visitors get the kind of accommodations they want. Wilson urged that reservations be sent to him right away.

Chairman of this year's general convention committee is Charles F. Stubbs of Alabama Gas Corporation, Birmingham, and his vice chairmen are Curtis M. Smith of Tennessee Gas Transmission Company, Houston, for the gas companies, and Charley Lockhart, Jr., of Bryant Heater Division, Dallas, for the manufacturers. W. M. Nunn, Sr., of New Orleans Public Service is chairman of local arrangements.

Other program features are:

Tuesday morning's general session—addresses by Frank C. Smith of Houston Natural Gas Corporation, president of the American Gas Association, and John H. Wimberly, also of Houston Natural Gas, president of SGA.

Wednesday morning's general session—Senator Dirksen's address and a talk by Paul Kayser, president of El Paso Natural Gas Company, Houston.

Wednesday's general session luncheon—"Here's How to Sell!" by Gene Flack, sales counsel and director of advertising for Sunshine Biscuits, Inc., New York.

Section chairmen and some of their program features are:

Accounting—Louis G. James, Lone Star Gas Company, Dallas. James C. Messer of Peoples Gas Light and Coke Company, Chicago, will talk on "Are You Cost Conscious?" M. S. Crossley, and J. R. Larimore, of Consolidated Gas Utilities Corporation, Oklahoma City, will present practical budgets for gas companies.

Distribution—R. A. Metzke, United Gas Corporation, New Braunfels, Texas. Repair practices for domestic meters will be discussed by L. A. Bickel of Lone Star Gas, Dallas, and plastic pipe by L. R. Pickup of Southern California Gas Company, Los Angeles.

Employee Relations—H. M. Rogers, Texas Eastern Transmission Corporation, Shreveport, Louisiana. Arthur Secord, supervisor of adult education at Brooklyn (New York) College will speak at the accident prevention forum and at one of the employee relations sessions.

Transmission—C. L. Perkins of El Paso Natural Gas Company, El Paso. Speakers include Frank Williams, Taylor Forge and Pipe Works, New York; Fred Hough, Southern Counties Gas Company of California, Los Angeles, and Dr. Frank J. Dotterweich of Texas College of Arts and Industries.

Program Plans for AGA Transmission Conference

Operating and technical personnel engaged in producing, gathering, transmitting, and storing natural gas are promised an intensive and instructive program at the first American Gas Association Transmission and Storage Conference at the Edgewater Beach Hotel, Chicago, April 30 to May 1. This conference is designed as the successor to the former Natural Gas Department spring meetings, which have been discontinued as a result of revisions in the AGA Constitution and By-Laws eliminating separate departments in the association.

Program committee for the conference at a recent meeting decided that conference sessions will be of two types. Mornings of the two-day meeting will be devoted to general sessions. Afternoon meetings will comprise informal, off-the-record discussion conferences.

Tentatively scheduled for general sessions are an address by AGA President Frank C. Smith; a report on the revisions to the ASA Code for Pressure Piping, B31, pertaining to gas transmission and distribution piping systems, and a paper on the phenomena of brittle fractures in steel. A representative of a natural gas storage company will describe the development and operation of an underground gas storage field. Other subjects for papers and talks include landholder-pipe line company relations, gas turbines and centrifugal compressors, and reports on several research projects pertaining to natural gas.

The report for the year 1952 on the statistics of underground storage in the United States will be presented by the chairman of the statistical subcommittee of the committee on underground storage.

Several conferences will be scheduled for each of the two afternoon sessions. These will begin at luncheon meetings and delegates will have a choice of attending conferences that will have special interest. Tentative subjects for the first day are corrosion, compressor stations, gas processing, and the revising of the B31 Pressure Piping Code. For the second day conferences will be held on underground storage operations, gas measurement, dispatching and communications, and pipe line construction and maintenance.

198 Years of Pipelining. The combined working days of these seven men, all retired, add up to that many years in varied types of employment with Service Pipe Line Company. Together recently in Hominy, Oklahoma, to honor John Evertz, center, when he retired as a district superintendent, they are, E. A. Price, Tulsa; Joseph Shaw, Hominy; John Copeland, Hominy; George Ogilvie, Tulsa; Evertz, now of Ada, Oklahoma; John Wertman, Chandler, and J. E. Laughorn, Cushing. Thirty-one Service Pipe Line Company employees retired in 1952. They worked 874 years with the company, an average of more than 28 years per man. Twelve of these had more than 30 years service, and three of the 12 had 35 or more years service.

United Gas Income Up

The 23rd annual report of United Gas Corporation described the year 1952 as one of major increases in volumes of natural gas sold and revenues from sales of gas and potash, and also showed increases in various operating expenses.

Natural gas sales in 1952 totaled 826 billion cubic feet as compared with 690 billion cubic feet in 1951. Much of this increase was made possible by the completion of major phases of United's Gulf South expansion program started in 1951. Revenues from sales of natural gas during the year were $118,207,897, an increase of more than $28,500,000 over 1951.

Sulfur and potash revenues in 1952 were $9,921,861, an increase of more than $5,000,000 over 1951. This increase in revenues resulted principally from the operation of a potash mine and mill by Duval Sulphur and Potash.

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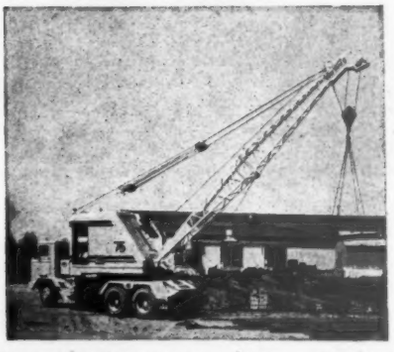
New Cranes Designed for More "On the Job" Time!

Handle all types of precision steel erecting, concrete work and any crane, clam, magnet or dragline job with the new standard-duty 75A or heavy-duty 75B Gar Wood cranes! . . . Collapsible high gantry simplifies raising of longest booms . . . Pendant cables speed changing of boom lengths . . . Optional *power load lowering* and *fluid coupling* give smoothest possible crane operation . . . Hammer head boom point keeps cable away from boom — gives added boom strength — keeps cable costs low . . . Crane sections pin and bolt connected for rigidity and strength . . . Right angle drive, power actuated hoist clutches and conical hook rollers . . . Easily converted to all attachments including the new, exclusive Gar Wood Foundation Borer!

FOR LIFTING POWER with MOBILITY

A Gar Wood 75BT truck crane will do the job. Lifts up to 40,000 lbs. Has all the heavy-duty features yet gets around fast. Ideal for long boom and steel erection work.



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F-532

Pipe Line News

Difficult River Crossing Made in Five Days

In the presence of a representative gathering of officials of government, industry, and labor, Trans Mountain Oil Pipe Line Company construction crews began the major crossing of the Fraser River at Port Mann on March 5. Five days were required to complete the work.

Canadian Bechtel, Ltd., are agents for the owner-company. Missouri Valley Canadian Ltd., Vancouver, contracted the crossing. B. C. Bridge and Dredging Company, Ltd., sub-contracted cutting a trench 15 ft in depth below the river bed.

There are 72 river and creek crossings on Trans Mountain's 718-mile route between Edmonton and Vancouver. About 20 are considered major crossings. The Fraser is crossed 10 times, but the Port Mann operation is the biggest of all.

There are several reasons. Port Mann is situated on the industrial tidewater. Studies had to be given to the varying currents of the turbulent Fraser, which in turn are affected by the incoming and outgoing tides of the Pacific.

Secondly, the crossing had to be made in shipping lanes, where the 2250-ft channel is traversed by considerable traffic, deepsea and coastal vessels, commercial fish boats, and tugs towing log booms to the lumber mills.

Investigations showed that the low water of winter, with a depth of approximately 40 ft, would be the best time to handle the job.

Total length of the contract, shores and water, was 5700 ft; from 200 ft south of Cornwall Street, Port Mann, to the Canadian Pacific Railway tracks running into New Westminster.

The Port Mann crossings consisted of three operations: First, the approach to the water from the south side; second, the approach from the north shore; and third, the actual river crossing.

On the south side it was necessary to tunnel a distance of 300 ft under the Canadian National Railways trackage in Port Mann yards. In this operation the 24-in. pipe was placed in a 30-in. steel casing as added protection. The job was completed without interruption to train schedules.

On the north shore the approach traversed 2447 ft of swamp. A corduroy road, topped with hog fuel (lumber mill chips), was laid down for transportation of 40-ft lengths of pipe with extra heavy wall thickness of ½ in.

Before placing the pipe under the river bed several protective operations were necessary, and they were carried out on the spot.

Pipe was given a primer coat of enamel to prevent corrosion. This was followed by an extra heavy coating of coal tar enamel, plus wrappings of glass fibre and asbestos felt.

Gunite process was then used to apply a 2½-in. coating of concrete interlaced with two layers of wire mesh.

Concrete serves a dual purpose, protection for the pipe, and sufficient weight to hold the pipe in place beneath the

river bed. The Gunite weighs approximately 200 lb to the foot. Total weight of pipe and wrappings is about 325 lb to the foot.

After the pipe was processed, it was placed on dollies and welded ready for launching in the river.

Two 1¼-in. wire ropes were used as pulling lines. They were independently secured to the end of the pipe and attached to two winches rated at 250-tons straight line pull. By this means the pipe was pulled into position beneath the river bed.

R. W. Otto Heads General Convention Committee AGA

Robert W. Otto, president, Laclede Gas Company, St. Louis, Missouri, has been appointed chairman of the general convention committee of the American Gas Association by Frank C. Smith, president of AGA. The 35th Annual Convention of AGA will be held at St. Louis, Missouri, October 26 to 28. Headquarters of the association, convention registration, and most meetings will be held in the Kiel Auditorium.

Industry executives who will assist Otto in supervising the financing, housing, arrangement of the general sessions program, and the scheduling of other convention events are: Eskil I. Bjork, president, The Peoples Gas Light and Coke Company, Chicago; Lyle C. Harvey, president and general manager, Affiliated Gas Equipment, Inc., Cleveland; J. T. Innis, vice president, Northern Natural Gas Company, Omaha; F. A. Lydecker, vice president, Public Service Electric and Gas Company, Newark, New Jersey, and James S. Moulton, vice president and executive engineer, Pacific Gas and Electric Company, San Francisco.

Also appointed to the general convention committee were: Arthur Stockstrom, president, Magic Chef, Inc., St. Louis; Henry Tuttle, president, Michigan Consolidated Gas Company, Detroit; John A. Weiser, executive vice president, The Newport Gas Light Company, Newport, Rhode Island; A. H. Weyland, president, Arkansas Louisiana Gas Company, Shreveport, and J. Theodore Wolfe, executive vice president, Consolidated Gas Electric Light and Power Company of Baltimore. Kurwin R. Boyes, secretary, AGA will serve as secretary of the committee and convention manager.

To provide opportunities for members of like interests to be together, the Statler Hotel has been assigned as the headquarters of the Accounting Section; the Jefferson Hotel as headquarters of the Residential Gas and the Industrial and Commercial Gas Sections, and the Lennox and Mayfair Hotels as headquarters of the Operating Section.

Hotel reservations will be handled through a housing bureau operated under supervision of the general convention committee. Members are urged to send applications for reservations as soon as possible to the Hotels Convention Bureau, American Gas Association, Room 405, 911 Locust Street, St. Louis 1, Missouri.

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A New 3/4 yd. Shovel with Many Exclusive Features!

Gar Wood has designed the *new* "75 series" shovels to combine many new and exclusive operating features with time-tested standards of advanced design and rugged construction . . . Both the standard-duty 75A and the heavy-duty 75B have *power actuated mechanical drum clutches, right angle drive, independent chain crowd, power steering, independent travel, conical hook rollers* to eliminate rocking and an optional *hydraulic coupling* to absorb shock loads . . . Easy field conversion for crane, clam, dragline, magnet, pile driver or trench hoe work . . . Don't miss checking the profit potentials of the exclusive new Gar Wood Foundation Borer — the machine that bores and bells in one operation . . . See your dealer for details —

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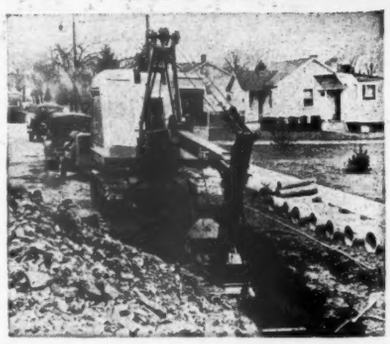

Your Gar Wood shovel can be quickly adapted for trench hoe work. Digs up to 17'10" depth, dumps at heights up to 19'3". Standard 40" dipper. 36", 31" and 26" widths optional.

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F-533

Pipe Line News

Service Electrifying Its Bowie Pump Station

Electrification of Service Pipe Line Company's Bowie pump station is scheduled for completion by June 1, J. P. Bradley, Bowie district superintendent, has announced.

Service personnel have poured foundations for the new station, a modern installation that will have two 1000-hp electric units. The company will raze the old brick station building, a Bowie landmark since 1919.

Electrification of the station is another step in the company's modernization program, launched last summer. Modernization of the station will result in some reduction of the Bowie station crew.

"While modernization may temporarily reduce crews at one location," Bradley pointed out, "it eventually provides more and steadier jobs elsewhere. Our company is growing and new jobs are being made in the new oil fields to which we are building lines."

He cited as an example the company's growth since 1945 when it employed 1990 men and women. Today it employs 2753. The East Texas division, of which Bowie district is a part, figured in that increase. In 1945 the division employed 240 men and women, today it employs 298.

Bowie district office staff, connection, construction and tank crews, and gagers, will not be affected by modernization of the station. Sixty-eight employees now have headquarters at Bowie. Service has maintained district offices at Bowie since 1931.

Service Pipe Line operates 12,456 miles of crude oil pipe lines in 11 states. An important point in the system, Bowie station is the junction for crude oil moved by lines from Central and West Texas. Bowie pumps the oil to Oklahoma for eventual delivery to refineries throughout the Midwest.

Interstate Lets Contract For 55-Mile Oil Line

Interstate Oil Pipe Line Company has announced the letting of a contract for the construction of 55 miles of 16-in. crude oil trunk line from Raceland, Louisiana, to Iberville Parish. The contract was awarded to L. E. Farley, Inc., Houston, Texas.

The new line generally will parallel Interstate's existing 8-in. line now in service. At Plaquemine it will tie into an existing 10-in. line which extends to Anchorage Terminal in west Baton Rouge Parish. The line will increase the capacity of the Raceland-Anchorage system to approximately 65,000 bbl a day.

This system provides trunk pipe line outlets for crude production from numerous fields in South Louisiana including Delta Farms, Bayou Perot, Golden Meadow, Little Lake, and others in the coastal area, and the Lake Chicot, Raceland, and Napoleonville fields in the Bayou LaFourche area.

Construction began the early part of March and completion is expected about June 15th.

EXCLUSIVE LEVERLOCK ASSURES POSITIVE OPERATION in W-K-M VALVES

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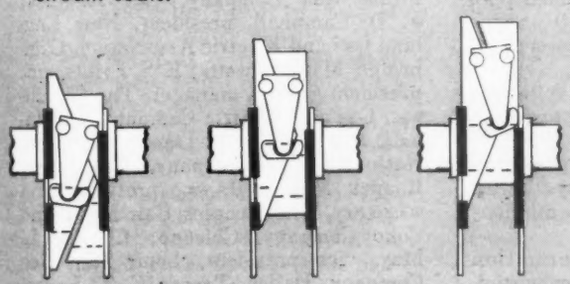

Gate and segment in closed position. Neutral position. Completely open.

The basic W-K-M Through Conduit Design and expanding gate have proved unequalled in the most severe tests. These, combined with Leverlock operation, no surge operation, simple maintenance, quick overhaul in the field, make W-K-M Pipeline Valves top standard for the industry. When you want dependable valve performance, specify W-K-M Valves all the way.

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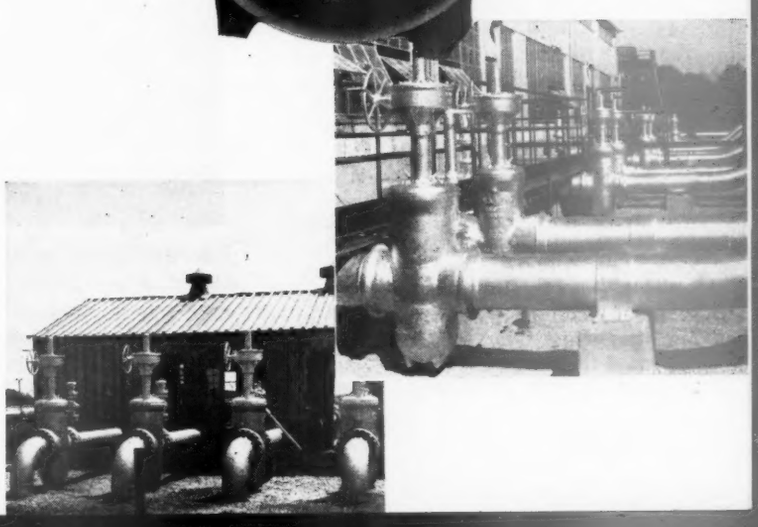


Rancho Pipe Line Begins Delivery of West Texas Oil

Oil is now being delivered through the new 457 mile, 24-in. diameter, Rancho Pipe Line system from West Texas to various refineries and terminals in the Houston area.

Construction of this newest "Big-Inch' pipe line in Texas was begun in March, 1952, and was financed with private capital by seven participating companies. It was designed and constructed by Shell Pipe Line Corporation. Ownership in the Rancho system is divided among Ashland Pipe Line Company, Crown-Rancho Pipe Line Corporation, Nantucket Pipe Line Company (a subsidiary of Eastern States Petroleum Corporation, Inc.), Pan American Pipe Line Company, Phillips Pipe Line Company, Shell Pipe Line Corporation and Sinclair Pipe Line Company.

The line originates at McCamey, Texas, and serves five refineries on the Houston ship channel and one at Sweeny, Texas. Initial capacity is 210,000 bbl per day with three pump stations. The line is so designed that its capacity may ultimately be increased, at such time as demand for crude may justify, to a maximum of 345,000 bbl per day by increasing the number of pump stations to eight.

Shackleford Is Speaker

R. E. Shackleford, general manager of the Perrault Equipment Co. in Tulsa, was chosen by the National Association of Corrosion Engineers as spokesman for U. S. coating equipment manufacturers at a Pipe Line Coatings Syposium in Chicago, Illinois, recently. Shackleford was on a panel of experts at a question-and-answer session during the two-day meeting.

Trans Mountain Line Expenditures High

Expenditures incurred by Trans Mountain Oil Pipe Line Company in connection with the construction of the 24-in. 718-mile crude oil pipe line between Edmonton, Alberta, and Vancouver, B. C., on the Pacific Coast had amounted to $46,852,339 as of December 31, 1952, Robert L. Bridges, president of Trans Mountain, stated in the company's annual report. Main 718-mile pipe line system, when completed according to current plans, will cost approximately $92,000,000.

Since the company was incorporated March 21, 1951, the company has earned no income, the report indicated. Its expenditures comprised $46,792,680 for engineering, surveys, work performed by contractors, materials supplied and net cost of interest during construction, and $59.659 for organization costs.

Whereas the original plans provided for the initial construction of a main 24-in. line with two pumping stations with an initial capacity of 75,000 bbl per day, in July of the past year a third pumping station was authorized. This increased the initial capacity of the line to approximately 120,000 bbl per day.

Public Relations Program Proposed for Gas Industry

Adoption of an integrated national and grass roots public relations program by the nation's gas utilities and pipe line companies is recommended by the American Gas Association in a special printed report mailed to all member companies of the association. Activity is to be financed outside association dues and calls for an expenditure of $155,000 the first year, $255,000 the second year, and $355,000 the third year.

Funds for the public relations program will be raised by voluntary assessment of utility companies based on a percentage of total gas sales revenue. Pipe line companies are to be assessed on a graduated scale based on gross revenue. The program becomes effective only if it is supported by companies representing at least 60 per cent of the total gas industry sales revenues.

Drawn up by the Committee to Study Public Relations, the program will be developed to the greatest extent possible through and with the cooperation of local gas utilities and pipe line companies. These companies will tell at the local level the story of gas and the gas business to their customers, empoyees, stockholders, and communities. On the national level, the association will conduct a coordinated program directed to opinion-forming groups and media. At the same time, AGA will stimulate the development of local and regional public relations programs and will provide information and counsel in support of such programs.

Committee report lists the following nine points as objectives of the proposed program:

1. Determine and evaluate public attitudes toward the gas industry.
2. Stimulate local public relations activity.
3. Provide expanded information service for local application by participating companies.
4. Promote informing of employees on the economics of the gas industry and the free enterprise system.
5. Inform the public on the economic and financial needs of the gas industry, and how these affect the public.
6. Encourage investment of funds in gas industry securities.
7. Present gas as an ideal fuel.
8. Cooperate with educational instituitions by providing informatiton.
9. Oppose encroachment of government in the field of private enterprise.

Need for such a program is urgent, according to the committee. The phenomenal expansion of the gas industry in recent years is believed to have outstripped the public understanding of the industry and its problems. Accordingly, it is considered necessary that gas industry employees, the public, governmental agencies, and leading opinion forming groups be informed more fully on the present stature, problems, and significance of the gas industry.

Recommendations culminate more than a year of study by the committee. They follow a preliminary survey, reported last May, which showed that 85 per cent of the responding companies favored a program of this character.

Ernest R. Acker, president, Central Hudson Gas and Electric Corporation, Poughkeepsie, New York, and a past president of American Gas Association, is chairman of the Committee to Study Public Relations. Other members are: F. M. Banks, president, Southern California Gas Company, Los Angeles; F. D. Campbell, president, New England Gas and Electric Association, Cambridge, Massachusetts; E. S. Fields, vice president-general manager, The Cincinnati Gas and Electric Company, Cincinnati, Ohio; W. H. Ligon, president, Nashville Gas Company, Tennessee; Remick McDowell, vice president and secretary, The Peoples Gas Light and Coke Company, Chicago; Chester L. May, vice president, Lone Star Gas Company, Dallas, Texas; F. T. Parks, vice president-gas operations, Public Service Company of Colorado, Denver, and Claude A. Williams, president, Transcontinental Gas Pipe Line Corporation, Houston, Texas.

Barrett Division of the Allied Chemical and Dye Corporation has recently placed in service one hundred 12,500-gal ICC 103-W tank cars built at the Milton, Pennsylvania, plant of the American Car and Foundry Company. These tank cars are of all-welded construction with all-welded underframes. Designed for the transportation of pitch and like commodities, they are equipped with 20 lines of heating coils. Each car has one ACF 3-in. lubricating plug valve in the bottom outlet chamber.

Pipe Line Personals

Sam C. Phelps, division engineer of Interstate Oil Pipe Line Company's Northern Division, has been made assistant chief engineer to succeed **Norman Tilden,** who is transferring to Creole Petroleum Corporation in Venezuela.

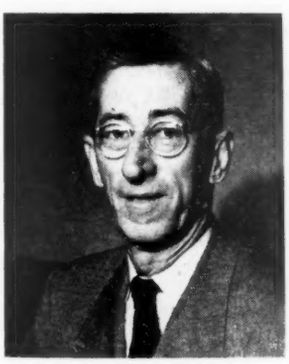
George C. Hughes succeeds Phelps as division engineer of the Northern Division. Hughes is former head of the research unit of the staff engineering department. He recently returned to the company's headquarters in Shreveport, Louisiana, from Washington, D. C., where he served with the Petroleum Administration for Defense while on leave of absence from Interstate.

Phelps joined Interstate's predecessor, Oklahoma Pipe Line Company, in 1943 as senior engineer. Before that he had completed a basic engineering course at Murray State School of Agriculture and had earned engineering degrees in both mechanical and electrical engineering at Oklahoma A. & M. College.

Hughes was employed by The Carter Oil Company and Stanolind Oil Company of Louisiana in geophysical work for two years prior to World War II and joined Interstate as an engineer in November, 1945.

Tilden began his career with Oklahoma Pipe Line Company in July, 1942, being employed as a junior engineer. In his new post with Creole he is pipe line operations Supervisor I.

Victor L. Rupe, Service Pipe Line Company, Tulsa, Oklahoma, recently was elected a member of The Pipe Liners Club of Tulsa. Other new members are **J. C. Nicholson,** The Natasco Company, Tulsa; **D. M. Hawkins,** manufacturer's representative, Tulsa, and **Ernest J. Liggett,** Johns-Manville Sales Corporation, Tulsa.



B. M. Cromack, Jr.

Bert M. Cromack, Jr., Service Pipe Line Company division gager at Hays, Kansas, has been promoted to assistant chief gager for the company with headquarters in Tulsa. **C. W. Butler,** Service operating superintendent, said Cromack would take the position formerly held by **J. M. Haskell,** who retired on annuity February 22 after 34 years' service with the company.

Cromack and **R. A. (Rudy) Hamill,** also an assistant chief gager, will assist **Bert Martin,** chief gager, in advising the company's 13 division gagers, 161 district gagers, and deliverymen, on crude oil gaging methods. Martin also supervises the strapping, or content measurement, of all tanks to which the company's line are connected on some 6360 leases, and 14,265,000 bbl of working tankage.

Cromack joined the company in May, 1921, as a laborer at Skiatook, Oklahoma. He worked in Oklahoma, Texas, and Wyoming as a timekeeper, warehouseman, and gager. In 1934 he advanced to district gager and was transferred to western Kansas where he ran the first oil from the Bemis-Shutts pool near Hays. In October, 1942, he joined the Corps of Engineers, and spent two years overseas. He served in India as assistant chief of pipe lines, supplying products to B-29's and other aircraft, flying the hump.

Captain Cromack was separated in 1946 and returned to Service Pipe Line as a district gager in western Kansas. He was promoted to division gager at Hays in 1948.

James A. Wilson, manager of the Houston, Texas, division of the United Gas Corporation, has been promoted to the newly created post of superintendent of Texas distribution operations. **C. L. Morgan,** Houston division superintendent, succeeds to Wilson's former post. **W. G. Meece,** assistant to vice president, **H. P. Carroll,** advances to a new position in the income tax department of the company's corporate office in Shreveport, Louisiana.

I. F. Bearden, assistant tank farm chief gager at McCamey, Texas, for Shell Pipe Line Corporation, has been promoted to station chief engineer at Scurry, Texas. **T. L. Brodie,** assistant station chief engineer at Huffman, has been made chief engineer there. **H. A. Brown,** district gager at Pauls Valley, Oklahoma, has been named district chief gager. **W. H. Bugg,** assistant mechanical maintenance supervisor at Chelsea, Oklahoma, has been promoted to supervisor. **O. G. Harvey,** station chief engineer at Huffman, has been transferred to Hankamer in the same capacity. **S. S. Lorenz,** assistant station chief engineer at Buffalo, Missouri, has been made station chief engineer at Labadie. **J. L. Seifert,** district gager, has been transferred from Tonkawa to Lucien, Oklahoma. **A. C. Webb,** station chief engineer at Hankamer, has been moved to Port Neches, Texas, as a chemist.

Albert C. (Court) Golden, Jr., has resigned as manager of the Pan American Gas Company and has been elected a director and vice president in charge of operations of the Pan American Pipe Line Company, it was announced by **I. O. Walker,** president of Pan American Pipe Line Company. Golden has also been elected a member of the executive committee of this company.

A. C. Golden, Jr.

Golden is a native of Sidney, New York, and after finishing high school in Albany, New York, majored in mechanical engineer at Rensselaer Polytechnic Institute in Troy, New York. He came to Texas in 1936 and after two years of "shovel" experience in the oil industry in West Texas and New Mexico, entered the service of Pan American Production Company in 1938 as a roustabout in the Charenton field, Louisiana. During the subsequent ten years, he served in various capacities in a number of fields in which Pan American Production Company operates in Texas and Louisiana. His last field job was district superintendent of Pan American's Southwest Louisiana District. In October, 1948, he was transferred to Houston as assistant to the vice president of Pan American Production Company, and on January 1, 1950, was appointed manager of Pan American Gas Company.

E. V. Hewitt, operating vice president of the Pan American Production Company, has been elected vice president and appointed general manager of operations of the Pan American Gas Company. Hewitt joined the Pan American companies in November, 1935, as a field foreman for Pan American Production Company, and in 1937 was promoted to assistant general superintendent, and in October, 1938, was made general superintendent. He was elected a vice president of Pan American Production Company in charge of all field operations and administrative matters in connection with his department on December 1, 1951.

Sidney M. Blair and **Donald Roberts** have been named directors of Canadian Bechtel, Ltd. Blair and Roberts are vice presidents of Canadian Bechtel, and in addition Blair is vice president of Trans Mountain Oil Pipe Line Company.

Blair attended the University of Toronto and received his master of science degree from the University of Alberta. Prior to joining Bechtal in 1949 he had been engaged in directing of manufacturing, engineering, and research activities in England, Caribbean area, and Canada.

Roberts joined Bechtal in 1942.

PIPE LINE PROGRESS

24-inch Rancho Pipe Line increases crude supply to West Gulf Coast refineries

Scheduled to start operation on March 1st, the new large diameter Rancho Pipe Line System, running from McCamey to Houston, Texas, supplies crude oil to Texas Oil Refineries.

Rancho's 467-mile pipe line starts in west Texas sand and caliche, traverses 270 miles of rocky country to the vicinity of Austin, then crosses cultivated fields, rivers, pecan orchards and rice fields to the outskirts of Houston.

Rancho is owned by Shell, Sinclair, Pan-American, Crown-Rancho, Nantucket, Phillips and Ashland pipe line companies. Shell Pipe Line Corporation was responsible for construction, started in March of 1952, and now operates the line. A. O. Smith supplied 340 miles of 24-inch welded steel Line Pipe for this project.

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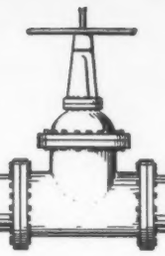
PIPE LINE PROJECTS



Examiner Approves of Construction Projects

A Federal Power Commission presiding examiner has filed a decision, subject to review by the commission, authorizing eight subsidiaries of The Columbia Gas System, Inc., to carry out natural gas pipe line construction projects.

The decision, filed by Examiner Ewing G. Simpson, at the same time denied applications by two other companies that were seeking supplies of natural gas from Columbia System subsidiaries. The decision involves rulings on a total of 13 applications by the 10 companies.

Applications that were granted were filed by Atlantic Seaboard Corporation, Virginia Gas Transmission Corporation, Central Kentucky Natural Gas Company, and United Fuel Gas Company, all of Charleston, West Virginia; The Manufacturers Light and Heat Company, Natural Gas Company of West Virginia, and Home Gas Company, all of Pittsburgh, Pennsylvania; and The Ohio Fuel Gas Company, of Columbus, Ohio.

The decision denies applications by Shenandoah Gas Company, of Lynchburg, Virginia, and Rockland Light and Power Company, of Nyack, New York, which had requested the FPC to order Columbia subsidiaries to supply them with natural gas, and authority to construct proposed new pipe line facilities to transport this gas.

Examiner Simpson's decision authorizes five applications by Ohio Fuel, involving a total of about 116 miles of new pipe line costing approximately $4,732,500.

Manufacturers, which had filed a joint application with Natural Gas Company of West Virginia and Home Gas Company, was authorized to build about 9.3 miles of pipe line and a measuring and regulator station, having a total cost of $348,700, and to retire approximately 15.6 miles of pipe line, a compressor station, and compressor unit.

Natural Gas Company of West Virginia received authorization for the construction of 21.3 miles of pipe line, having a total estimated cost of $840,000, and the retirement of 14.7 miles of pipe line, all in Columbiana County, Ohio. The company also would retire two compressor units in Stark County, Ohio.

The decision authorizes Home Gas Company to construct a total of 19 miles of pipe line in Chemung, Tioga, and Broome counties, New York. Estimated cost of these facilities is $668,000.

The United Fuel Gas Company project involves the construction of pipe line facilities in West Virginia to expand the company's underground gas storage operations and to replace existing facilities. United would build a total of 21.5 miles of pipe line and a total of 4840 compressor hp. Total estimated cost of these projects is $2,411,600 over and above $1,171,040 for acquiring and activating the storage fields. The construction includes a new 880-hp compressor station and an additional 3960 hp at an existing station on United's system in the general area of Charleston, West Virginia.

Atlantic Seaboard Corporation received authorization for two compressor stations in Pendleton and Hardy counties, West Virginia, with a total capacity of 7640 hp. Estimated cost of the construction is $3,335,000.

Central Kentucky was authorized to construct 8.8 miles of line looping an existing line extending northward through North Means, Kentucky.

Shenandoah Gas Company had proposed to construct about 30 miles of pipe line, with five short laterals.

The examiner also denied Rockland's application, which requested the commission to order Home Gas Company to supply it with natural gas for resale in Orange County, New York.

United to Get Further Hearing on Offshore Line

The Federal Power Commission has ordered additional hearings on an application by United Gas Pipe Line Company, of Shreveport, Louisiana, to construct about 31 miles of natural gas pipe line extending from an off-shore field in the Gulf of Mexico to a connection with the company's existing system in Terrebonne Parish, Louisiana.

The commission ordered the additional hearings, to be held at a time and place to be fixed by further order, as it modified and affirmed a decision filed last November by FPC Presiding Examiner Glen R. Law.

FPC said that the record shows, as found by the examiner, that United has not proved the existence of sufficient available gas reserves to justify construction and operation of the proposed pipe line. The commission pointed out that a substantial and relatively inexpensive supply of gas would be available to United through the project, with corresponding benefits to the company and its customers. The FPC noted that drilling operations in the area covered by the contract has not ceased, and that the drilling should reach the 14,000-ft depth, from which United claims the bulk of the gas reserves to support its application, "within a reasonable time." The commission added that "it is appropriate on the particular facts of this case" that United be given further opportunity to present evidence.

Colorado Interstate Files Two Pipe Line Applications

Colorado Interstate Gas Company, of Colorado Springs, Colorado, has filed two applications with the Federal Power Commission, proposing the construction of natural gas transmission facilities in Colorado, Wyoming, Texas, Oklahoma, and Kansas, and having a combined estimated overall capital cost of $43,155,249.

The company is proposing in one of the applications to construct a 365-mile, 22-in. pipe line extending to Denver, Colorado, from a connection near Green River, Wyoming, with the natural gas transmission system proposed to be built by Pacific Northwest Pipeline Corporation. This project, estimated to cost $23,298,653, also would include a 5500 hp compressor station at Green River, and necessary metering and regulating facilities.

Colorado Interstate plans to purchase an average of 100,000,000 cu ft of gas per day from Pacific Northwest, which now has an application pending before the FPC for the construction of a pipe line system extending from the San Juan Basin in New Mexico and Colorado to market areas in the Pacific Northwest.

In the other application, Colorado Interstate is proposing to construct 49 miles of 20-in. gas pipe line and a total of 24,860 hp in compressor capacity at new and existing stations. This construction program, in Colorado, Oklahoma, Texas, and Kansas, is estimated to cost $19,836,596.

In connection with its application to construct the Green River-Denver line, Colorado Interstate said that its total firm peak day gas requirements on its system are estimated at 575,800,000 cu ft for the 1954-55 winter heating season, whereas its supply and capacity would limit it to a delivery of 508,800,000 cu ft on such peak days—even assuming the construction of the facilities proposed in the other application.

Phillips Plans Extension Oil Gathering System

Phillips Pipe Line Company, a wholly-owned subsidiary of Phillips Petroleum Company, has announced plans to extend its crude oil gathering system in southeastern Kansas, pending approval by Petroleum Administration for Defense.

Project will consist of 6½ miles of 4-in. pipe line to gather oil from the Beal water flood unit and 2½ miles of 2-in. pipe line to gather oil from the Cartwright water flood unit, both in Greenwood County.

The project will connect these water flood units with the company's Thrall, Kansas, pump station, a junction point.

Consolidated Hearings Begin in Washington

Consolidated hearings began March 25 in Washington, D. C., before the Federal Power Commission on applications of Texas Illinois Natural Gas Pipeline Company and Chicago District Pipeline Company, both of Chicago, Illinois, subsidiaries of The Peoples Gas Light and Coke Company.

Texas Illinois is proposing to increase the daily delivery capacity of its pipe line system from the presently authorized 374,000,000 cu ft a day to 504,000,000 cu ft. The company plans to build six new compressor stations and additional units in existing stations to effect the 130,000,000 cu ft per day increase. The application also requests authority for the construction of a suspension bridge across the Mississippi River and lateral pipe lines that would connect gas reserves to the company's system. Total estimated cost of the project is $42,148,000.

Chicago District is seeking authorization for the construction of about 35 miles of natural gas transmission line in the Chicago, Illinois, area, to enlarge the capacity of its system to enable it to meet increasing requirements of existing customers. Estimated cost of the project is $5,500,000.

The commission denied requests by both companies that their applications be heard under the shortened procedure for noncontested proceedings.

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Natural Gas to Plant Petitioned from FPC

The Federal Power Commission is holding hearings in Washington, D. C., on an application by Northern Natural Gas Company, of Omaha, Nebraska, proposing to construct pipe line facilities to supply natural gas to the nitrogen division of the Allied Chemical and Dye Corporation for use in a plant to be built near La Platte, Nebraska, for the production of urea and other fertilizer products.

In a two part application, Northern is proposing first to construct pipe line facilities to sell and deliver gas to Allied on an interruptible basis; and second, to build additional facilities to deliver and sell on a firm basis up to 12,000,000 cu ft of gas per day for use at the plant.

Tennessee Gas Files Amended Application

Tennessee Gas Transmission Company has announced the filing of an application with the Federal Power Commission in Washington for authority to build facilities to perform a natural gas transportation service for two gas companies with headquarters in Buffalo, New York, and Toronto, Canada.

Under the proposal, the Iroquois Gas Corporation of Buffalo and Niagara Gas Transmission Limited of Toronto, who have purchased natural gas in Texas and Louisiana, would contract with Tennessee Gas to transport their gas to the points in New York where their systems intersect the lines of Tennessee.

Application amends one filed by Tennessee Gas in June, 1952, to transport gas for the Niagara company alone, and provides a substantial enlargement of the services sought to be rendered.

Tennessee Gas would transport the gas for delivery in western New York to Iroquois Gas, and at the United States-Canadian border to Niagara Gas. Amount to be transported for Iroquois Gas would be 48,752,000 cu ft a day, and for Niagara Gas 60,700,000 cu ft a day.

As the gas to be transported is from reserves not committed to Tennessee Gas, the proposed transportation service will not affect reserves committed to its other customers, the application pointed out.

Facilities costing $91,718,000, which would be constructed, include a 574-mile, 30-in. pipe line from Kinder, Louisiana, northeast through Louisiana, Mississippi, and Tennessee to join the present Tennessee Gas system at Portland, Tennessee; approximately 130 miles of loop line in Texas, Louisiana, Ohio, and Pennsylvania; a 45-mile, 20-in. spur line from the Tennessee Gas Line near Buffalo to a point on the United States-Canadian border near St. Catharines; a submerged crossing of the Niagara River; 17,520 additional hp at existing compressor stations, and 21,280 hp in three new compressor stations near Yazoo City, Mississippi; Morehead, Kentucky, and Findley Lake, New York, plus 158 miles of lateral pipe lines in Louisiana and Texas.

FPC Gives Final No To Texas-Ohio Gas

The Federal Power Commission has affirmed as its final decision the opinion and order issued last November 7, denying applications by Texas-Ohio Gas Company, of Houston, Texas, for authority to construct a 1406-mile pipe line and to import natural gas from Mexico.

The commission by order issued December 31 designated the November 7 opinion as a tentative decision, and parties to the proceeding had 20 days in which to file exceptions. Exceptions were filed by Texas-Ohio, Reserve Natural Gas Corporation, and the Public Utilities Commission of Ohio. Texas-Ohio planned to sell its gas to Reserve Natural, a newly formed corporation, at the terminus of the proposed line near Lancaster, Ohio.

Texas-Ohio's proposed pipe line, estimated to cost $185,000,000, would have extended from the U. S.-Mexican border in Hidalgo County, Texas, to the Ohio terminus. In its November 7 opinion and order, the FPC found that Texas-Ohio "has failed on this record to show that the proposed service, construction or operation is or will be required by the present or future public convenience and necessity."

In affirming the November 7 opinion as its final decision, the commission said it was not adopting the "Findings and Conclusions in Lieu of Tentative Decision" submitted by Texas-Ohio and Reserve Natural because it found, and now finds, that Texas-Ohio "on the whole record has not made a showing that it has an adequate supply of gas to warrant the issuance of a certificate . . ."

Noting that the two companies have requested a reopening of the record "to confirm the present availability" of gas supplies, the FPC pointed out that four separate hearing sessions have already been accorded Texas-Ohio to permit it to make the showing required by the Natural Gas Act, and that no showing was made of the additional evidence to be offered. The commission said that "we do not believe it would be in the public interest to grant this request to reopen."

The commission noted that in its tentative decision it had referred to the fact that Reserve Natural, as the proposed purchaser of Texas-Ohio's entire sales capacity, has no firm commitments for the resale of the gas, and that the record would not support any definite conclusions as to the manner or method of disposition of gas by the company.

Under the Natural Gas Act and the Administrative Procedure Act, the FPC continued, the applicant has the burden of meeting the statutory requirement that it is "able and willing properly to do the acts and to perform the service proposed . . . and that the proposed service . . . is or will be required by the present or future public convenience and necessity; otherwise such application shall be denied." The commission said that "we have found and now find that applicant has failed to sustain that burden by the weight of credible evidence. Therefore, we have no alternative but to deny the applications."

Examiner Approves Southern's Request for Expansion

A Federal Power Commission Presiding Examiner has filed a decision, subject to commission review, authorizing Southern Natural Gas Company, of Birmingham, Alabama, to construct facilities to increase the daily delivery capacity of its natural gas pipe line system from 670,000,000 cu ft to 1,020,000,000 cu ft daily.

The decision, filed by Presiding Examiner Emery J. Woodall, also authorizes South Carolina Natural Gas Company, of Columbia, South Carolina, and South Georgia Natural Gas Company, of Birmingham, Alabama, both new corporations, to construct pipe line systems to transport natural gas.

Southern Natural project will extend the company's system from its present southeastern terminus near Bass Junction, Georgia, to Aiken, South Carlonia, and Savannah, Georgia. In addition to service to the South Carolina and South Georgia companies, new customers to be served through the facilities include 17 communities in Alabama and Georgia; the Southeast Alabama Gas District; South Atlantic Gas Company, which now distributes manufactured gas in Savannah, Georgia; and 7 direct industrial customers. In addition to authorizing the new service proposed by Southern, Presiding Examiner Woodall also directed the company to supply natural gas to five other Georgia communities. Service to other municipalities in Alabama and Georgia will result from authorizations granted by this decision.

Decision also authorizes Southern to sell gas to several communities and industrial customers in Georgia and South Carolina as approved or directed by an FPC order issued in May of 1950 authorizing construction of a pipe line extending from Bass Junction, Georgia, to Aiken, South Carolina, The May, 1950, order authorizes a 10¾ and 8⅝-in. line between these points, but Southern, because of the growth of its markets in this area, subsequently sought authority to subsitute 14-in. pipe, and then the 16-in. that is here authorized.

Southern's construction program, estimated to cost $44,932,600, includes about 522 miles of pipe line additions to the company's existing system together with 9800 hp in compressor capacity, and approximately 270 miles of new pipe line and a new 4400-hp compressor station. The commission already has granted temporary authorization for the construction of about 109 miles of the pipe line covered by this decision.

Southern's application also covered construction of a gas supply system extending southward from a point of connection in the Gwinville, Mississippi, gas field with Southern's existing lines to the Gulf of Mexico. This phase of the construction program, estimated to cost about $32,518,500, and including more than 326 miles of pipe line and approximately 8700 hp in compressor capacity, was authorized by the FPC last October 31, and was thus removed from the scope of the decision.

South Georgia Natural Gas Company was authorized to construct 335 miles of pipe line extending southeast from a point on Southern's system in Lee County, Alabama, through southwestern Georgia and into Florida. The total cost of construction is estimated at $8,141,518. Capacity of the company's projected system will be approximately 20,000,000 cu ft of gas a day.

South Carolina Natural Gas Company's project includes approximately 160 miles of pipe line extending southeast from the proposed eastern terminus of Southern's system near Aiken, South Carolina, to sell gas to South Carolina Electric and Gas Company, of Columbia, South Carolina, at the city gates of Columbia, Charleston, and Summerville, South Carolina, and to the municipalities of Bamberg, Denmark, Orangeburg, and Walterboro. South Carolina Natural plans to purchase 30,000,000 cu ft of gas a day from Southern Natural. Total overall construction cost of the project is estimated at $5,945,000.

Natural Gas Rate Increases To Become Effective

Suspended wholesale natural gas rate increases by two Columbia Gas System, Inc., subsidiaries will become effective as of February 15 upon the companies' posting of bonds with the Federal Power Commission and subject to the refund of any amounts subsequently disallowed by the FPC.

The increases, by Central Kentucky Natural Gas Company and United Fuel Gas Company, both of Charleston, W. Va., were filed with the FPC last August 15 and were suspended by Commission orders issued on September 12. The Natural Gas Act provides that, upon a company's motion, a rate increase shall become effective after a five-month suspension period if the proceeding has not been concluded. Both companies filed motions February 11 requesting that their increases go into effect at the expiration of the suspension period, on February 15.

Central Kentucky's increase amounts to approximately $1,085,000 per year and United Fuel's totals about $6,974,000 annually. The Commission's orders require Central Kentucky to post a $100,000 bond and United Fuel to post a bond of $700,000.

Both companies must refund, together with interest at the rate of 6 per cent per year, any portions of the respective increases subsequently found by the Commission not to be justified. The Commission's orders also require the companies to keep accurate accounts of all amounts received by reason of the increases and to report the same to the FPC monthly for each billing period.

Kansas-Nebraska Given Final Construction Authority

The Federal Power Commission has affirmed, with modifications, a decision by an FPC Examiner authorizing Kansas-Nebraska Natural Gas Company, Inc., of Phillipsburg, Kansas, to construct pipe line facilities on its natural gas transmission system in Kansas and Nebraska to increase the daily capacity by 9,990,000 cu ft of gas, from the presently authorized 182,600,000 cu ft to 192,590,000 cu ft.

The Commission modified the decision, filed by Examiner Francis L. Hall, to include a condition requiring that no new service proposed by the company in its application be rendered until Kansas-Nebraska has initiated all-firm service to all communities which it previously has been authorized to serve.

Project, estimated to cost about $2,576,686, includes the construction of approximately 196 miles of pipe line.

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Pipe Line Projects

Gas Pipe Line Will Serve Louisiana Chemical Plants

The Texas Company has begun the installation of extensive facilities to gather, compress, transport, and market natural gas produced in the Terrebonne Bay and adjacent areas in south Louisiana, it was announced by J. N. Troxell, general manager, Texaco's producing department, and J. H. Rambin, Jr., division manager, Louisiana division, producing department.

The facilities, including a gasoline plant at Paradis in St. Charles Parish, Louisiana, and a total of 111 miles of pipe lines, will supply natural gas requirements of American Cyanamid Company and Lion Oil Company for large chemical plants on the west bank of the Mississippi River in the New Orleans area.

Estimated requirements for these plants are 40,000,000 cu ft a day. The gas to be supplied to these new plants will be flare gas from the Gulf Coast.

Areas from which the gas will be produced include Caillou Island, Lake Barre, Leeville, Golden Meadow, Lake Pelto, Bay de Chene and Bay Ste. Elaine in Terrebonne and Lafourche parishes.

Rights-of-way have been obtained by The Texas Company and plans made to construct pipe lines, varying from 6-in. to 14-in. in diameter, which will extend 111 miles in linking up the fields to the gasoline plant at Paradis. Plans also provide for the installation of five compressor stations along the system of pipe lines, the nucleus of which will be a 42-mile, 14-in. gas artery.

An unusual feature is that two of the compressor stations will be mounted on submersible barges in Terrebonne Bay to deliver gas into the main transmission lines at high pressure to the American Cyanamid and Lion Oil plant sites.

Combined horsepower of the five units will be approximately 9240.

Construction and operation of the extensive gas system and the Paradis plant will be under the management of Louisiana division manager Rambin, and A. B. Wardlaw, superintendent of gas and gasoline plants in the Louisiana division.

FPC Authority Asked Gas Storage Area Expansion

Iroquois Gas Corporation, of Buffalo, New York, has applied to the Federal Power Commission for authority to construct pipe line facilities in connection with the development of the Aurora field near Aurora and Colden, New York, as a storage area for natural gas.

The company plans to develop the field to an estimated capacity of approximately 1.6 billion cubic feet of active gas, and to construct about 6 miles of 16-in. pipe line to connect the storage area with its system. Total estimated cost of the proposed project is $800,000. Company proposes to begin construction as early in 1953 as the weather permits, so that the field can be used to some degree during the 1953-54 winter, and to complete the project by the end of 1954.

FPC Hearing Being Held On Proposed Pipe Line

A Federal Power Commission hearing began April 6 in Washington, D. C., on related applications of Permian Basin Pipeline Company, of Chicago, Illinois, Northern Natural Gas Company, of Omaha, Nebraska, and El Paso Natural Gas Company, of El Paso, Texas.

Permian is proposing to build a pipe line system in Texas and New Mexico through which 300,000,000 cu ft of natural gas per day will be delivered to El Paso, which will then deliver this gas back to Permian for delivery and sale to Northern. Permian will deliver the gas to El Paso at an interconnection in Yoakum County, Texas, and El Paso will redeliver an equivalent quantity back to Permian at a point near El Paso's Dumas compressor station in Moore County, Texas, at which point Permian will deliver the gas to Northern.

Permian plans to construct a total of 164 miles of pipe line and 54,880 hp in compressor units in Texas and New Mexico at a total estimated cost of $42,530,000. Northern would build approximately 429 miles of main pipe line, 62,400 hp in compressor capacity, and numerous branch lines and branch line additions.

Estimated cost of the line is approximately $66,248,000.

El Paso proposes to construct compressing, measuring and regulating facilities. These facilities are estimated to cost $2,900,000.

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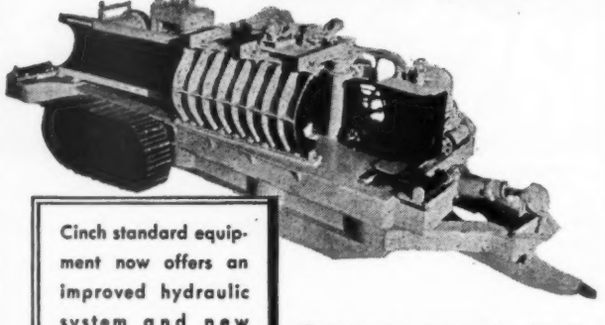

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*Position*_____

*Home Address*_____

*Office Address*_____

*City*_____ *State*_____

With the PIPE LINE CONTRACTORS

Midwestern Constructors, Inc., 105 North Boulder, Tulsa, Oklahoma, expect to begin work about May 1 on 97 miles of 30-in. pipe line for Mackinac Pipe Line Company, Inc., from Cooks, Michigan, to St. Ignace, Michigan. Mackinac is owned by Lakehead Pipe Line Company, Inc., and the agent for the project is Bechtel Corporation. M. T. Wilhite will be superintendent in charge and John Work spreadman.

The company's progress report on other jobs as of the middle of March is as follows:

Aluminum Ore Company, Bauxite, Arkansas: Process piping installation, 96 per cent completed. Earl S. Powell is superintendent, Morris Garey office manager, and Ralph Bray area superintendent.

Sinclair Pipe Line Company, Independence, Kansas: Construction of pump station at Quincy, Illinois, 99 per cent completed. Ray M. Johnson is superintendent and Fred Trompler office manager. Construction of pump station at Pontiac, Illinois, 95 per cent completed; Charles Malone superintendent and W. D. Kaufman office manager.

Reynolds Metals Reduction Plant, Arkadelphia, Arkansas: Underground work sub-contracted from Aluminum Constructors Mechanical Trade, 70 per cent completed. Additional extensions were awarded March 5. K. L. Kreamalmyer is superintendent.

L. E. Farley, Inc., 2609 Sunset Boulevard, Houston, Texas, has been awarded a contract by Interstate Oil Pipe Line Company to lay 55 miles of 16-in. pipe line from Raceland to Plaquemine, Louisiana. Construction began the early part of March with completion expected by June 15.

River Construction Corporation, 6100 Camp Bowie Boulevard, Fort Worth, Texas, has been awarded a contract for two related projects by Interstate Oil Pipe Line Company. One is the construction of 22 miles of 18-in. trunk line from the Louisiana-Texas state line to Finney pump station, about 10 miles southeast of Shreveport, Louisiana. The second is 28 miles of 22-in. from Finney station to a point about 5 miles northwest of Coushatta. The 18-in. job was scheduled to begin about April 1, with the 22-in. project starting upon its completion. Both jobs are expected to be completed by June 15.

Williams-Austin Company, Grant Building, Pittsburgh, Pennsylvania, reports construction projects as follows:

Niagara Mohawk Power Corporation —52 miles 10-in. line from Fulton to Watertown, New York; Howard Bauer, superintendent.

Buckeye Pipe Line Company—Approximately 102.5 miles of 10 and 14-in. line from New York-Pennsylvania line near Binghamton, New York, to Auburn and Syracuse; O. L. Martin, superintendent.

New York State Natural Gas Corporation—Approximately 10 miles 20-in. line in Driftwood, Pennsylvania, area; Ralph Gaddy, superintendent.

Ed Peters is general superintendent over all jobs. Preliminary work on all jobs was scheduled to start April 1. The central warehouse for all work is Cortland, New York—Phone 23.

Texas Eastern Transmission Corporation, Shreveport, Louisiana, has let three pipe line construction jobs and four river crossings according to an announcement by B. D. Goodrich, vice president and chief engineer.

Associated Pipe Line Contractors, Inc., of Houston, Texas, will construct 75 miles of 24-in. pipe line from Lavaca County, Texas, to Waller County, Texas.

Williams Brothers Company of Tulsa, Oklahoma, was awarded construction of 71.4 miles of 24-in. pipe line from Polk County, Texas, to Shelby County, Texas; construction of the Neches and Angelina River crossings, and construction of the Attoyac Bayou crossing.

Anderson Brothers Company of Houston, Texas, will construct 82 miles of 24-in. pipe line from Waller County, Texas, to Polk County, Texas.

Pentzien Inc., of Omaha, Nebraska, was awarded river crossings for the Trinity, Brazos, Colorado, and Sabine rivers.

H. C. Price Company, Bartlesville, Oklahoma, has been awarded a contract by the Tennessee Gas Transmission Company of Houston, Texas, for construction of 74 miles of 24-in. high pressure gas pipe line in northeastern Pennsylvania.

The new line will extend in a northeasterly direction from a point near Mercer, Pennsylvania, and will form the main portion of an extension to TGT's newly developed underground storage facilities near Cowdersport, Pennsylvania.

HCPCO's Spread 1 under Superintendent G. A. "Abe" Reutzel has been assigned to the TGT construction. Equipment is being moved by rail and truck from Princeton, Kentucky, to the new spread location at Oil City, Pennsylvania.

Anderson Construction Company, Box 116, Salem, Illinois, is laying approximately 33 miles of 4 and 6-in. pipe line from the Ashland Oil and Refining Company from Woodlawn to Coulterville, Illinois. Gayle Gibson is superintendent; Samuel C. Wilson, office manager; Thomas Clark, right-of-way; Parker Brothers of Centralia, Illinois, subbed-stringing; Ernest L. Matney, ditch; Charley Lane, bending and pipe; Fred Phelps, dope and lower-in; B. L. Clark, road crossings and tie-ins, and Merle Erle, clean-up. L. W. Ramsey is chief inspector.

Bills Construction Company, Box 644, Tulsa, Oklahoma, is laying 17 miles of 8½-14-in. and 8½-8-in. line from Mocaugie Station, Pennsylvania north and east near Allentown, Pennsylvania. Carl W. Bills is superintendent and R. E. (Smoky) Wallace is assistant superintendent, with Vivian Grizzell, office manager. Foremen include: Row, W. E. Sains; ditch, B. C. Carter; pipe, Robert Lankford; road crossings, I. R. White; dope, Hugh Clements; lower-in, Walter Colligan; welding, Kenneth Mills. W. C. Allred and Carl W. Bills are handling this work as a joint venture.

Field office address for this work is Ranch House Motel, R 3, Allentown, Pennsylvania. Work should be completed May 1, but has been slow due to snow and rain.

Bills and Troth Construction Company, 428 Wright Building, Tulsa, Oklahoma, a partnership, has been dissolved.

Houston Contracting Company, Ltd., 2707 Ferndale Place, Houston, Texas, has the following construction work under contract:

Approximately 40 miles of 16-in. natural gas line for Houston Pipe Line Company from vicinity of Edna, Texas, to the Tom O'Connor gas field. F. A. Silar is superintendent; L. F. Redfearn, field office manager. Headquarters are at Victoria, Texas. Job was delayed because of bad weather but pipe laying began March 3.

Approximately 50 miles of 30-in. natural gas line for Tennessee Gas Transmission Company in the vicinity of Sinton and El Campo, Texas. First headquarters, Sinton, Texas; W. H. Hayes, superintendent; M. L. Thompson, assistant superintendent; J. B. Stoddard, field office manager. Job delayed by bad weather but started laying pipe February 25. Same spread will complete the work at Sinton and move to El Campo.

Approximately 2 miles of 6-in. feeder line including a 12-in. Trinity River crossing for Tennessee Gas Transmission Company in the vicinity of Cleveland, Texas. R. E. Thornton is superintendent; Geo. E. Warner, office manager; headquarters, Cleveland, Texas. Job started March 5.

Approximately 525 miles of 24-in., 20-in., 16-in., and 14-in. natural gas lines for Southern Natural Gas Company in Georgia, Alabama, Mississippi, and Louisiana. Expect to begin preliminary right-of-way work in Louisiana in late March and in Mississippi about April 15, with laying operations several weeks later. Starting dates for work in Alabama and Georgia delayed account clarification of permits but will probably be June. Work in southeast Louisiana to be handled by F. A. Silar spread with first headquarters at Hammond, Louisiana. Mississippi work to be handled by W. H. Hayes spread with first headquarters at Prentiss, Mississippi.

Contractors

Wilcox Trend Gathering System, Inc., Dallas, Texas, has awarded a contract for pipe line construction to H. B. Zachry Company of San Antonio, Texas, according to an announcement by Harry W. Bass, president of Wilcox Trend. Contract includes the construction of 116.8 miles of 14 and 16-in. pipe line from Duval County, Texas, to DeWitt County, Texas, and crossing of the Guadalupe River.

Altgelt Construction Company, Inc., of Corpus Christi, Texas, has been awarded the construction of approximately 85 miles of laterals and gathering lines.

Brown and Root, Inc., of Houston, Texas, was awarded the construction of a 2200 hp compressor station to be built near Thomaston, Texas.

The construction is scheduled for completion in the summer of 1953.

Sheehan Pipe Line Construction Company, 529 National Bank of Tulsa Building, Tulsa, Oklahoma, has completed laying 84 miles of 12-in. between Unionville and Polo, Missouri, for Standard Oil Company of Indiana, and is now doing the cleanup.

Williams Brothers Company, National Bank of Tulsa Building, Tulsa, Oklahoma, has opened a field office at Lufkin, Texas, to lay approximately 80 miles of 24-in. pipe line for the Texas Eastern Transmission Corporation. The section extends from Corrigan to Center, Texas. O. R. Mitchell is in charge.

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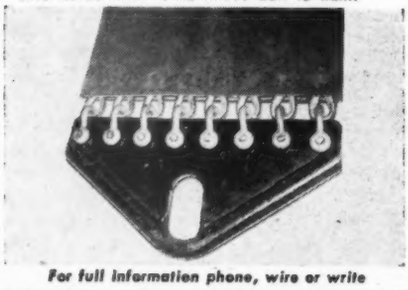
Our Belt-Sling has proved far superior in strength and durability to any other belt on the market.

The load is carried by a center layer of wire rope, cushioned by rubber covered belting; they definitely will not mar a coated pipe. One man can easily hook up our Belt in a matter of seconds as there is no heavy bolt to fight.



For full information phone, wire or write

Vic Knudsen Rigging Co.

134 Sacramento St., San Francisco 4 — Sutter 1-1367

Engineering-Construction Company, 402 North Cheyenne, Tulsa, Oklahoma, began work in March on about 37 miles of 6 and 8-in. pipe line for the Cooperative Refining Association between Holdredge, Nebraska, and Phillipsburg, Kansas. The field office is at Alma, Nebraska; telephone 207. Earl Hackelman is spreadman and Dave Wells has charge of the office.

Another job that recently got underway is the takeup and relay of line in Oklahoma City for Oklahoma Natural Gas Company. This consists of taking up approximately 11 miles of 12, 16, and 20-in., and laying about 7½ miles of 24-in. and 3½ miles of 20-in. "Hedge" Edmonds is spreadman, H. B. Hoge office manager, "Big Jim" Hickman pipe gang foreman, George Taylor welding foreman, and B. K. Alley material man and timekeeper. Telephone number of the field office is Melrose 41635 in Oklahoma City.

Beginning about April 15, 50 miles of 18-in. pipe line will be laid for Oklahoma Natural from Sapulpa to the Pryor-Chouteau, Oklahoma, industrial area. Location of the field office has not been determined. Contemplated personnel includes "Hedge" Edmonds as spreadman, "Big Jim" Hickman pipe foreman, Emerson Clark office manager, and B. K. Alley material man and timekeeper.

Brown and Root, Inc., 4100 Clinton Drive, Houston, Texas, has a contract covering 194 miles of 6, 8, 12, and 20-in. pipe for Southern Natural Gas Company near Morgan City, Louisiana.

Project is divided into two sections. One is 50-mile area from the Mississippi River to Lake Sand. Second consists of about 144 miles in the Louisiana coastal area.

Jimmy Kincy will be one superintendent in charge, with a field office at Morgan City, Louisiana. Operations began about April 1.

Company has completed 28 miles of 26-in. for Pan American Pipeline Company from Texas City to Genoa, Texas. Kincy was in charge.

Carl H. Dunn, Burkburnett Building, Fort Worth, Texas, is taking up 30 miles of 8-in. pipe between Fairfield and Elkhart, Texas. Fred Peters is spreadman, and Walter Elliott, office manager. Field office is at Elkhart.

Jack Graham, P. O. Box 1203, Amarillo, Texas, has 25 miles of 1-10-in. natural gas lines at army base near Brownwood, Texas. Enix Construction Company is main contractor. Grant W. Fowler, is superintendent.

Fulghum Contracting Corporation, Camp Hill, Pennsylvania, has been awarded the contract to lay 51½ miles of 14-in. pipe line for the Buckeye Pipe Line Company from Dupont, Pennsylvania, north to the Pennsylvania-New York state line.

Lone Star Construction Company, Box 55, Winnie, Texas, has 4.5 miles of 8-in. pipe for Texas Gas Corporation at Winnie. N. C. Reese is superintendent with Everett Reese in charge of welders.

Fifteen Fellowships Offered by IGT

Fifteen fellowships will be offered in 1953 by the Institute of Gas Technology, an affiliate of Illinois Institute of Technology, it is announced by E. S. Pettyjohn, director of IGT.

Two programs are available for graduate students preparing for careers in the gas industry. One offers a master of science degree in mechanical or chemical engineering in 15 months; the other, a master of gas technology degree in two years. Outstanding students may be granted fellowship extensions for work on the doctor of philosophy degree.

Fellows receive tuition, fees, and a stipend, starting at $140 a month.

It takes two summers and one full academic year to obtain a master's degree in mechanical or chemical engineering. Introductory courses in gas technology are taught during the first summer. During the regular school year, appropriate engineering courses are combined with continued study of gas technology, and work is started on a research project. The second summer is devoted to completion of research work and preparation of a thesis.

The program for the master of gas technology degree includes engineering and business studies, plus research. These students work in the gas industry during the second summer, and receive the salary of a cadet engineer. Classroom work, research projects, and the thesis are completed during the second academic year.

Enrollment will be in mid June, although exceptions may be made for winter graduates.

Application forms may be obtained from local gas companies or by writing the director of the Institute of Gas Technology, 17 West 34th Street, Technology Center, Chicago 16, Illinois.

Welding Exhibits Planned

Exposition management for the American Welding Society's forthcoming Exposition, running from June 16 through 19 at the Shamrock Hotel Hall of Exhibits in Houston, Texas, has just announced the virtual sell-out of exhibit space for this all-welding show. Although they will strive to accommodate late-comer reservations, still being solicited, current exposition management operations include final preparations for assisting exhibitors with exhibit arrangements.

Many of the leading manufacturers who make welding and allied products for various industries will exhibit and demonstrate their equipment. These include Reduction Sales Company, Aluminum Company of America, General Electric, Harnischfeger Corporation, International Nickel Company, Lukens Steel Company, Magnaflux Corporation, Nelson Stud Welding Division, Sylvania Electric Products, Inc., Tweco Products Company, Union Carbide and Carbon Corporation, and Westinghouse Electric Corporation who have already begun their individual exhibit preparations.

Removal of Large Micron Dust Particles IS NOT ENOUGH!

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take out the SMALLEST PARTICLE of pipe line dust

Repeated tests have proved it's the *small* dust particles which cause the most trouble and damage in gas systems. Pilot stoppages, for example, are caused by dust particles ranging in size from 10 microns to less than one micron.

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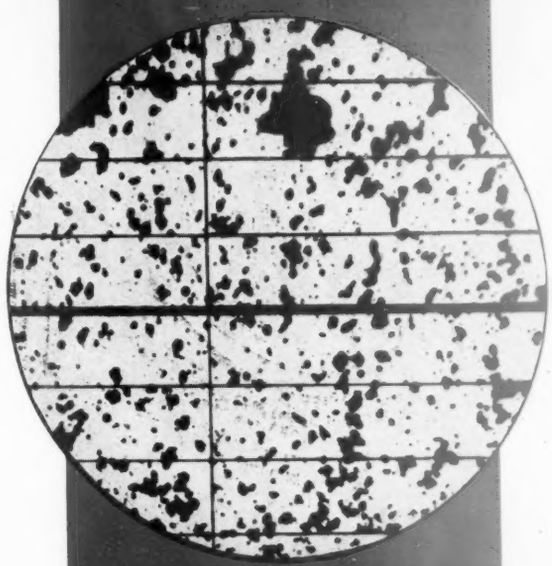
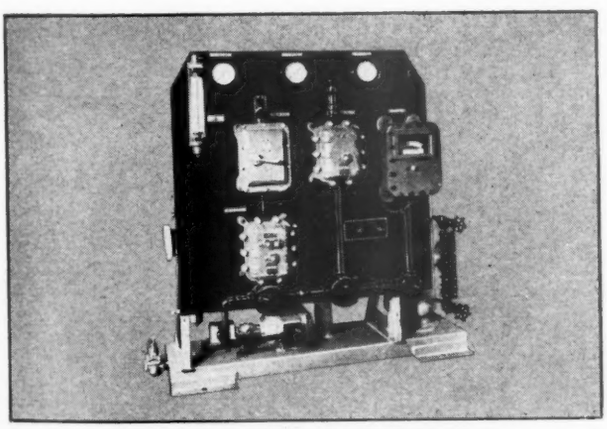
is the only gas cleaning method definitely known to remove even the smallest dust particles from gas. Blaw-Knox Oil Bath Process Gas Cleaners give you much more than a high percentage of dust removal —they clean out the smallest particle of dust from your gas stream and effectively stop plugging of pilot orifices and damage to regulators, compressor parts and metering devices. They cut maintenance and service costs and improve customer relations by providing *clean* gas at all times. For complete information, write for Bulletin 2353.

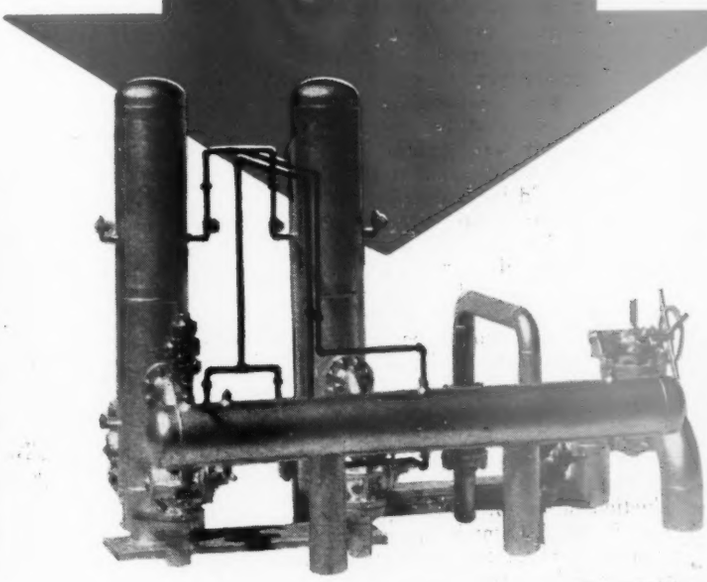


Photomicrograph (200X) of dust removed by Blaw-Knox Gas Cleaner. Each line is one micron (.000039 in.). Note that many particles are of sub-micron size.



BLAW-KNOX ELECTROIL FOGGER

These approved units are now fogging millions of cubic feet of gas hourly. They are made in standard and portable sizes.



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U. S. Oil Imports Stay At New Record Highs

Crude oil imports into the United States rose sharply during the week ended March 14. According to the American Petroleum Institute total imports were 1,135,100 bbl per day, up from 1,061,000 average the week before.

Week ended	Crude oil	Residual oil	Others	Total
February 21	658,600	413,000	9,600	1,081,200
February 28	568,500	439,900	12,600	1,021,000
March 7	595,800	508,000	13,600	1,061,000
March 14	740,800	377,400	16,900	1,135,100

Below are exports as reported by the Petroleum Administration for Defense. Figures are in thousands of barrels.

	Avgas	Motor gasoline	Kerosine	Distillate	Residual	Total
January 23	19.5	43.2	13.1	109.7	79.8	265.3
January 30	12.4	36.3	12.3	48.8	19.8	129.6
February 6	29.6	7.0	6.5	95.5	23.3	161.9
February 13	48.4	43.2	18.2	129.6	29.0	268.4
Four weeks ending February 13	27.5	32.4	12.5	100.2	38.0	210.6

NPC Group Reports on Oil Requirements in U. S.

Chairman of the National Petroleum Council, Walter S. Hallanan, has announced appointment of a Committee on Oil and Gas Exploratory and Development Requirements. The Committee was appointed in response to a request from the Deputy Petroleum Administrator that the Council make a study as to the minimum requirements of manpower, equipment, and materials for all phases of oil and gas exploration and development such as geological and geophysical, leasing, exploratory or wildcat drilling, development drilling, producing, and services (well logging, cementing, gun perforating, drilling mud, etc.), and that for the purpose of such a study well drilling rates of the year 1953 and 10 per cent above the year 1952 should be assumed.

In the request, the Petroleum Administration for Defense pointed out that its studies of petroleum requirements in event of an all-out war indicate that continuous drilling of a substantial number of wells would be necessary year by year throughout the war period.

Texas Oil Allowables Receives Sharp Cutback

Texas received another cut in its oil production allowables in April. The Texas Railroad Commission made the biggest cut in permitted crude oil output since July of last year. The state is producing 2,921,875 bbl a day, off 119,366 bbl from that of March 14, making the fourth month in five output had been reduced. There was a slight increase in February.

The Commission cut the number of days of flow to 19 from 21 last month. East Texas field remains on 18 days.

Louisiana's oil output was cut this month by 15,500 bbl per day, making a total of 694,344 bbl daily.

Proved Reserves Climb to Highest in History

Proved reserves of liquid petroleum and gas reached new heights in 1952, according to the American Petroleum Institute and the American Gas Association. Substantial increases were made in both categories, meaning that petroleum and natural gas were added to known underground stocks in spite of new record-high production levels.

Reserves indicate known supplies buried in the ground, location, and extent of which have been established by the industry's continuous drilling program. They do not include any estimate of oil and gas that may be later found under acreage of ground in U. S. but is as yet untested.

Proved reserves of liquid petroleum went up to 32.9 billion barrels as of last December 31 — an increase of more than 764,000,000 bbl over 1951's former peak.

Proved reserves of natural gas rose to 199.7 trillion cubic feet by the year's end—an increase of 5.9 trillion cubic feet over the preceding year.

Production of both oil and natural gas smashed all records in 1952, liquid petroleum output having amounted to 2.5 billion barrels, an increase of 60,000,000 bbl over 1951, and natural gas 8.6 trillion cubic feet, an increase of 672 billion cubic feet over 1951.

Following comparative liquid hydrocarbon and gas reserves at the end of 1951 and 1952, and the production of liquid hydrocarbons and natural gas during those two years are indicated in the following report:

	December 31, 1951	December 31, 1952	Increase 1952 over 1951
		Barrels	
Crude oil	27,468,031,000	27,960,554,000	492,523,000
Natural gas liquids	4,724,602,000	4,996,651,000	272,049,000
Total liquid hydrocarbons	32,192,633,000	32,957,205,000	764,572,000
		Thousands of cubic feet	
Natural gas	193,811,500,000	199,716,225,000	5,904,725,000

Production	1951	1952	Increase 1952 over 1951
		Barrels	
Crude oil	2,214,321,000	2,256,765,000	42,444,000
Natural gas liquids	267,052,000	284,789,000	17,737,000
Total liquid hydrocarbons	2,481,373,000	2,541,554,000	60,181,000
		Thousands of cubic feet	
Natural gas	7,966,941,000	8,639,638,000	672,697,000

New supplies developed in	1951	1952
	Barrels	
Crude oil	4,413,954,000	2,749,288,000
Natural gas liquids	723,991,000	556,838,000
Total liquid hydrocarbons	5,137,945,000	3,306,126,000
	Thousands of cubic feet	
Natural gas	16,185,742,000	14,544,363,000

Estimated proved reserves of liquid hydrocarbons in the U. S.
(Barrels)

	Proved reserves as of Dec. 31, 1951 (add 000) (1)	Changes in proved reserves due to extensions (new oil) and revisions during 1952 (add 000) (2)	Proved reserves discovered in new fields and in new pools in old fields in 1952* (add 000) (3)	Production during 1952 (add 000) (4)	Proved reserves as of Dec. 31, 1952 (Col. 1+2+3 less Column 4) (add 000) (5)	Changes in reserves during 1952 (Column 5 less Column 1) (add 000) (6)
Alabama†	7,860	460	8,400	1,085	15,635	7,775
Arkansas	387,508	42,020	2,431	28,827	403,132	15,624
California**	4,090,186	430,438	45,017	388,963	4,176,678	86,492
Colorado	337,088	2,454	8,435	30,947	317,030	— 20,058
Illinois	670,907	29,427	3,811	64,438	639,707	— 31,200
Indiana	50,816	14,602	2,194	11,908	55,704	4,888
Kansas	951,515	227,912	26,202	120,413	1,085,216	133,701
Kentucky	69,027	7,310	1,962	13,576	64,723	— 4,304
Louisiana**	2,969,554	454,875	110,634	263,867	3,271,196	301,642
Michigan	65,122	4,843	1,479	13,450	57,994	— 7,128
Mississippi	437,677	4,524	6,464	38,925	409,740	— 27,937
Montana	111,759	30,272	27,150	9,871	159,310	47,551
Nebraska	18,504	2,300	6,313	2,565	24,552	6,048
New Mexico	742,259	188,352	24,252	69,962	884,901	142,642
New York†	57,061	—	—	4,207	52,854	— 4,207
North Dakota†	4,983	43,200	29,440	1,420	76,203	71,220
Ohio	28,146	4,398	11	3,387	29,168	1,022
Oklahoma	1,787,582	237,002	33,312	215,370	1,842,526	54,944
Pennsylvania	97,565	38,073	107	11,381	124,364	26,799
Texas**	18,192,305	791,478	222,453	1,164,977	18,041,259	—151,046
Utah	29,744	13,000	1,420	1,708	42,456	12,712
West Virginia	62,683	1,758	220	7,921	56,740	— 5,943
Wyoming	1,019,326	157,945	16,387	71,846	1,121,812	102,486
Miscellaneous††	3,456	1,387	2	540	4,305	849
Total United States	32,192,633	2,728,030	578,096	2,541,554	32,957,205	764,572

* Only a limit area is assigned to each new discovery, even though the committee may believe that eventually a much larger area will produce; for, in this report, the concern is only with actually proved reserves.
**Includes off-shore reserves.
† Crude oil only.
†† Includes Alabama and North Dakota natural gas liquids; Missouri, Tennessee, and Virginia crude; and Florida crude and natural gas liquids.

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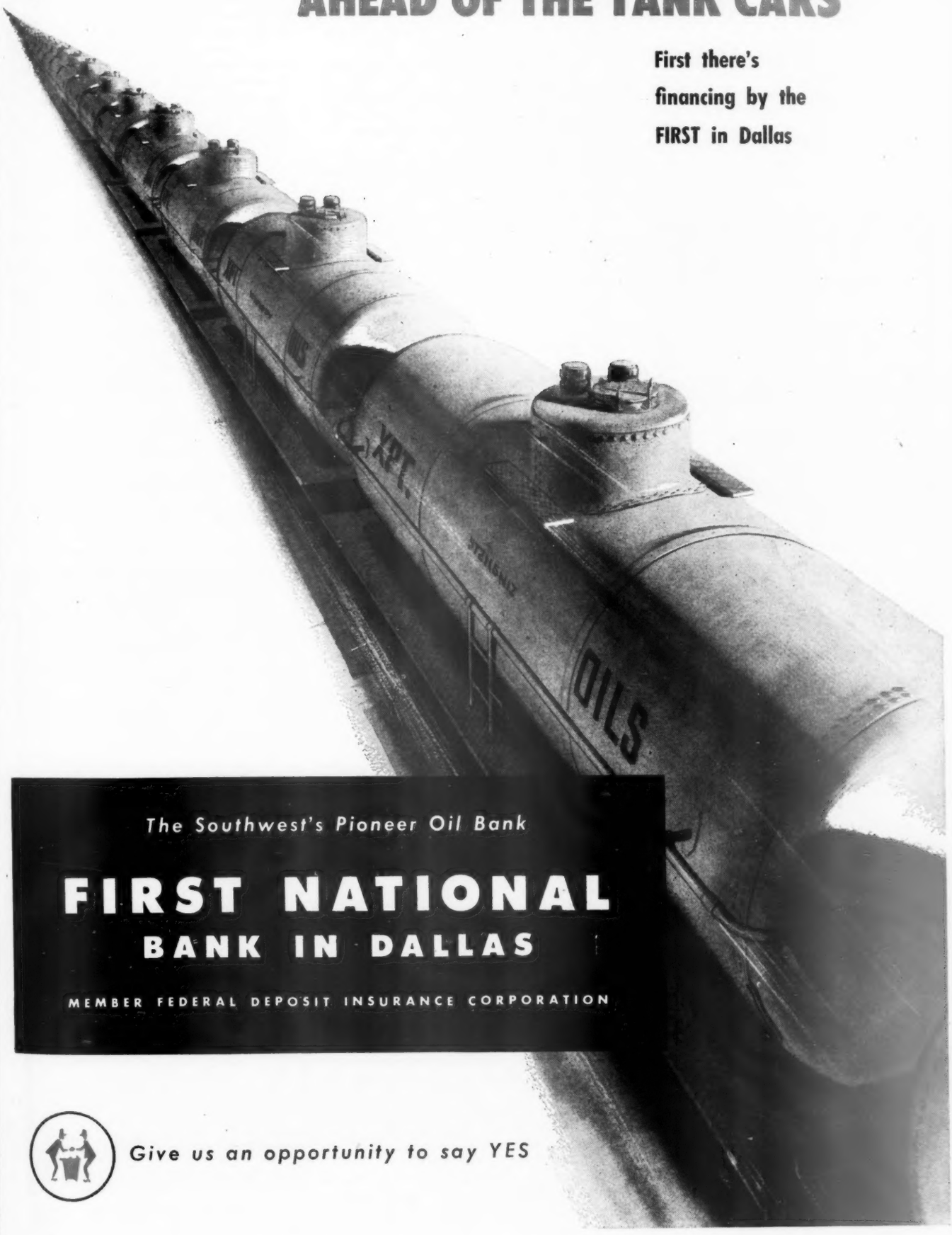

The Southwest's Pioneer Oil Bank

FIRST NATIONAL BANK IN DALLAS

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Give us an opportunity to say YES

Gasoline Prices Up Some Areas; Hikes Rescinded in N. Y.

In some parts of New York state, gasoline prices are right back where they were before price controls were removed. Although several major oil companies had hiked prices ½ cent per gallon, the raise has been rescinded because other major companies did not raise their prices.

Socony-Vacuum, Gulf Oil, Sinclair, and Atlantic Refining have brought posted prices back to their former places before price controls went off.

Socony made the first boost in price of ½ cent, followed by the others within five days. Gulf Oil executives announced a few days later that "in the light of unsettled market conditions and competitive pressures," we have found it advisable to restore prices in effect before the recent advance of ½-cent a gallon in New York and England.

Other prices throughout the country ran as follows:

Ohio Oil has announced 1-cent a barrel increase in prices it will pay for crude from Wyoming.

Esso Standard reported it did not plan to raise gas prices at this time. "We do not think that at this time the present ample supply situation warrants a general increase," Esso president, S. C. Hope announced.

In Ohio major oil companies are waging a sales battle. Standard Oil Ohio has reduced its wholesale price of gasoline to bulk buyers, and has been followed by Ohio Oil, Cities Service, Gulf Refining, and others.

Richfield Oil has raised wholesale prices on all petroleum products except lubricating oil throughout its West Coast marketing area. Posted prices on both regular and premium grades of gasoline will be increased 1.6 cents a gallon in the Los Angeles, San Francisco, Seattle, and Portland areas, it was announced. Throughout the company's marketing area, embracing California, Oregon, Washington, Arizona, Nevada and Idaho, the wholesale gasoline price increase will average approximately 1.5 cents a gallon.

Standard Oil of California has increased the price it pays for crude oil by from 10 cents to 50 cents a barrel. At the same time, the wholesale prices of finished products also will be raised. The price of motor and aviation gasolines will be increased generally 1.6 cents a gallon; heating oil and diesel fuels 1.8 cents a gallon, and heavy residual fuel oils 10 cents a barrel.

Rise in Gasoline For Aviation Foreseen

Increases in consumption of aviation gasoline by civilian aircraft in the United States amounting to more than 30 per cent by 1955 and more than 60 per cent by 1962 over 1952 levels are estimated by the Petroleum Administration for Defense in a long-range study of future aviation-gasoline demand. Deputy Petroleum Administrator J. Ed Warren announced.

Increases in consumption by foreign aircraft, civilian and military, are projected at 19 per cent by 1955 and 28 per cent by 1962 over total foreign demand for aviation gasoline last year.

Education Meeting Planned

Underlying theme of the 1953 annual meeting of the American Society for Engineering Education this June will be a broad evaluation of the job that the engineering colleges perform, said ASEE President Willis R. Woolrich in announcing the preliminary program. This 5-day yearly convention will be held at the University of Florida, Gainesville, from June 22 to June 26 and luncheons and dinners will be given.

Hungary's Oil Output

In listing Hungary's oil production last month (March, Page A-44) a zero was unintentionally left off. Guesstimate of Hungarian production is 9000 bbl a day, but it came out 900. Other estimates run as high as 13,500 bbl a day. If this is true, then production is highest since 1946 and hardly calls for convicting 24 of the oil industry staff of sabotaging its operations.

Gas Tax Rise Denounced

The rising threat of increased taxes on natural gas has brought a sharp protest from Chester L. May of Dallas, Texas, Lone Star Gas Company vice president who called for "a broadening of the tax base so that other sources would more nearly carry their share of the tax burden." His action was reflected in a letter cautioning Lone Star industrial consumers that "additional taxation of Texas natural gas would further discriminate against industry of the state."

May contends that gas going into interstate pipe lines cannot be taxed without the same tax being imposed on the gas consumed in Texas. He charged that the natural gas industry—"and consequently the users of natural gas"—has been and is now taxed beyond the rate at which other major natural resources are taxed.

GREAT BEND
FISHING TOOL CO.
GREAT BEND, KANSAS
affiliated with

ACME
OIL TOOL COMPANY
• COMPETENT OPERATORS
• ROTARY FISHING TOOL SERVICE
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• COMPLETE OIL FIELD MACHINE SHOP
ACME'S HYDRAULIC SHOCK-ABSORBING . . .
WASHOVER OVERSHOT
will catch a fish in a
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Bell Report Denies Import Rate Too High

A report denying that imports are excessive and prices inadequate to encourage oil exploration has been turned in by Donald Bell, head of the Mutual Security Agency's public advisory board.

Report was made to President Eisenhower, and defended imports from the national defense standpoint, adding that foreign oil development should be encouraged so that in event of war foreign oil could be diverted to our overseas troops. In the future, imports could be limited if found detrimental to the domestic industry, the Bell Report said.

As concerns depletion tax of 27½ per cent, the report stated, "Over the life of the property it is possible for the tax-free recovery to reach a total greatly in excess of this investment."

Russell Brown, general counsel for Independent Petroleum Association of America announced his association would present its case to Congress, showing that imports are excessive and are already a detriment to the oil industry.

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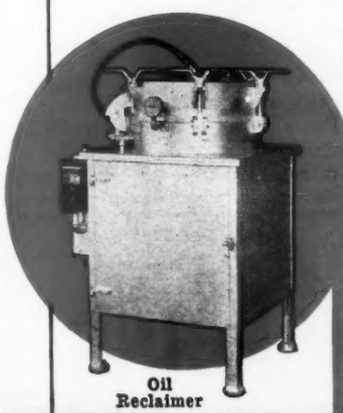

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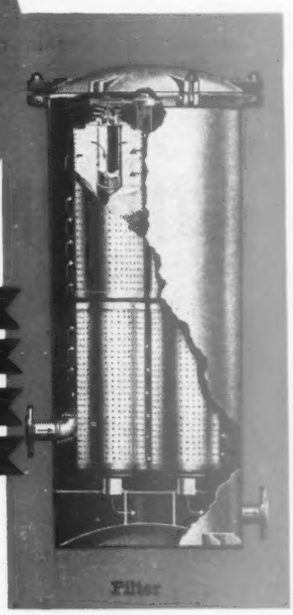

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NPC Declares Shale Oil Is Uneconomical Now

The National Petroleum Council has completed a $500,000 study in which it concluded that Bureau of Mines proposals for the manufacture of synthetic gasoline from coal and oil shale are "definitely uneconomical under present conditions" and that "the need for a synthetic liquid fuel industry in this country is still in the distant future."

In its summary of the study, the NPC also cast doubt on the value of the Bureau of Mines' multi-million dollar demonstration plants and questioned "the wisdom of government financing" of these huge experimental units.

It pointed out that when the need arises in the U. S. for synthetic gasoline, entirely new techniques, now unknown, may be available. "Such techniques," the NPC said, "can be developed from well designed pilot plants at a fraction of the cost of the big, expensive demonstration plants."

Since 1944 over $74,000,000 has been appropriated for the Bureau of Mines Office of Synthetic Fuels for its development program.

The NPC undertook its two-and-a-half-year investigation of the Bureau's design and cost data at the request of the Secretary of the Interior.

W. S. S. Rodgers, chairman of The Texas Company, headed the NPC committee on Synthetic Liquid Fuels Production Costs which was responsible for carrying out the Government request.

CHRISTENING AIRLINER that will carry out the first non-stop flight between Tulsa, Oklahoma, and Chicago, Illinois, is Glennis Dickerson, of Tulsa Desk and Derrick Club. Braniff Airways recently scheduled the flight between the two cities in advance of the Tulsa Oil Show. With Miss Dickerson is L. S. Allen, chairman of Tulsa Chamber of Commerce Aviation Committee.

He reported the committee had concluded that: Gasoline manufactured from oil shale would cost the wholesale purchaser 14.7 cents a gallon at the refining point.

Gasoline made from coal by the Bureau of Mines Fischer-Tropsch process would cost 29.4 cents a gallon.

And, gasoline made from proposed hydrogenation processes would cost at least 36.3 cents a gallon.

These wholesale prices would exceed all the current wholesale price of gasoline refined from crude petroleum which is about 12 cents a gallon at the refinery or terminals. Wholesale prices do not include sales taxes and marketing and transportation expenses.

In Denver, Dr. W. C. Schroeder, assistant director of the Bureau of Mines, said if the U. S. is going to keep up with Russia's output, it had better turn to its shale oil reserves. Speaking before the oil shale section of the Western Mining Conference, Dr. Schroeder said there had been more progress than popularly believed in the development of synthetic oil. He said at the Bureau's pilot refinery, Rifle, Colorado, gasoline could be produced and delivered by pipe line to California for 12 cents a gallon.

Henquet Opens Paris Office

Roger Henquet, former general manager for Schlumberger Well Surveying Corporation in the U. S. A., announces the opening of petroleum engineering offices in Paris, France, under the firm name, *Societé d'Etudes Petrolières.* Headquarters have been established at 6 Avenue Franklin Roosevelt in Paris. Until recently, Henquet has been Eastern Hemisphere representative for Superior Oil Company and in charge of the firm's Paris headquarters.

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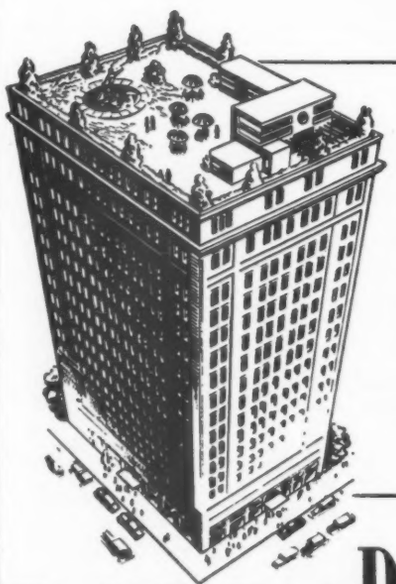

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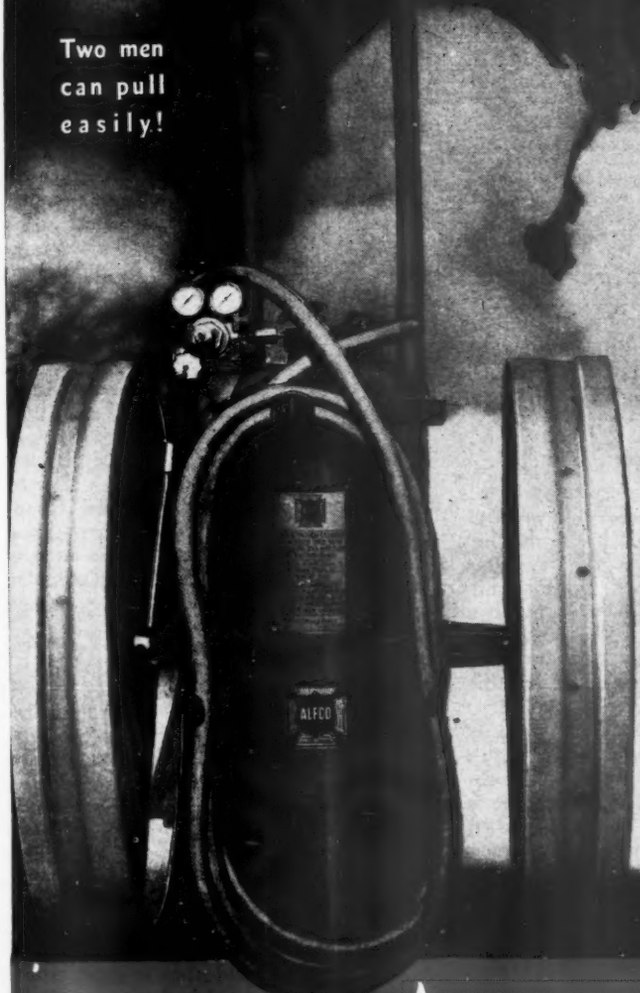

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To obtain more information on products advertised see page E-59

Tulsa Oil Show Will Have Some 400 Displays

Latest trends in petroleum industry operations will be viewed by spectators who visit the International Petroleum Exposition, May 14-23 in Tulsa, Oklahoma.

Since its beginning in 1923, the oil show has provided a means whereby industry personnel, from field men to top executives, could observe a wider variety of competitive equipment, service and material in a few days.

At this 30th anniversary affair, viewers will see many items for the first time. The most technically advanced and expensive end of the oil business—drilling—will be portrayed by some 400 displays valued at an estimated $30,000,000.

LONGEST AND NARROWEST building in the world is this 10-ft wide and 1000-ft long structure being built at the Tulsa Oil Show site to accommodate demands for exhibit space. Electricians busy on the building are Doc Hunt, left, and Leslie Chapman.

Emphasis on advancements for other divisions will also be afforded visitors, both in the Hall of Science and in the displays of more than 1500 exhibiting organizations in the 30 acre plant.

Exploration exhibits, nearly 150 in all, will preview the latest improvements in seismic, gravity meter and magnetic principle units for oil "prospecting."

More than 300 refining exhibits, accentuating petrochemistry and developments for processing crude petroleum products, will be featured. Achievements in the struggle for higher octane ratings, combatting corrosion, and new storage and handling methods are among the many displays designed for the highly specialized technologist as well as the layman.

Plastic pipe, new coatings and materials, improvements in high-speed, lightweight unitized pipe line machines will be encountered by observers seeking information from nearly 375 displays pointed to the transportation division.

In the production field, there will be many exhibits pertinent to secondary recovery operations, which is one of the most unusual and important developments within the industry since the 1948 show. Water-flood seems the favorite mode at present for reactivation of drive, consequently the majority of exhibits will attempt to enlarge upon some of the problems common to that operation. Water treatment, filtration, purification equipment and methods will be presented for appraisal, and much new information is to be made available.

Progress in methods of analysis on grain structure, types, permeabilities, porosities, adhesive and cohesive characteristics of possible fluids in place, the use of detergents for breakdown of molecular "clustering," and fluid tension will undoubtedly attract attention from observers, too.

Despite the apparent industry preference for water drive, there will also be several displays concerning gas injection, and much data are expected on equipment for this method.

For the first time, a plastic tank will be presented at the exposition, and this new development is among those causing much speculation on future developments and applications. A novel mechanical "brain" that will automatically record the oil, gas and BS&W any given well produces is to be displayed, showing that an operator can run any number of wells into one tank and still distinguish what each well is producing.

It may be noted that there will be more extensive display of lighter equipment, nevertheless capable of performing larger, heavier jobs. The accent in "bigness," per se, is being shifted to improve the ratio of weight-power-cost in oil field equipment.

Efficiency seems to have become the desired ingredient or characteristic, and there will be much emphasis placed on units featuring better integration, higher operating speeds, and greater power delivery at the point of application. There is, too, a trend toward greater portability in some fields, partially due to more stringent highway restrictions.

One of the surprising facts encountered concerning drilling equipment, rigs, and machines, is that at this stage of progress in the industry with more rotary drilling rigs in operation than ever before, there are more cable tool machines produced, sold and in operation than the industry, domestically, at least, has ever witnessed. High portability, packaged or highly integrated machines stressing speed of movement, rig up, and marked increase in penetration speed, also, have been essential features stressed by displays.

Improved drilling equipment covering every phase of the activity will be well covered with improvements shown in everything from crown sheaves to special purpose rock bits.

Platform for Industry

A nine-point "platform for industry" was outlined by an oilman in Tulsa, Oklahoma, as the best way for private enterprise to combat socialistic trends.

A. L. Solliday, executive vice president of Stanolind Oil and Gas Company, predicted that if business and industry "cannot or does not accomplish the things in this platform, then the people will look again to the government or labor for their accomplishment." He spoke before a general session of the spring meeting, Mid-Continent district, Division of Production of the American Petroleum Institute.

Solliday's platform for industry includes these nine points:

(1.) Make and distribute quality products, in ample supplies, at fair prices. (2.) Help maintain purchasing power of employees by paying fair wages. (3.) Try to minimize slumps brought on by seasonal trends or the turns of the business cycle. (4.) Provide, in addition to fair wages, good working conditions and ample opportunities for advancement. (5.) Provide, insofar as necessary, for the welfare of employees. (6.) Continue to retain only fair and reasonable profits. (7.) Expend whatever money and effort are required to locate and develop ample natural resources, or to develop substitutes if they are needed. (8.) Devote an important amount of effort to research—toward the goal of more and better things for more people at less cost. (9.) Provide opportunities for creating new jobs, investing whatever capital may be necessary.

AIOC Oil Claim Denied

A Venice, Italy, court has ruled that the 35,000 bbl of oil brought to that city by the tanker Miriella had been legally purchased by Supor Company of Rome from Iranian National Oil Company, and therefore Britain's Anglo-Iranian Oil Company had no claim on it. AIOC had sought to gain control of the oil on the basis Iran had illegally expropriated and nationalized the company's holdings in southern Iran.

Britian had said that compensation would be worked out in a manner "fully compatable with the rehabilitation of Iran's economy." Foreign Minister Hussein Fatemi said Iran would not be able to agree on generalities until the British clarify meaning of compensation.

OFFICERS FOR 1953 elected by the Dallas Desk and Derrick Club recently, are: Front row, Hazel Jeans, Harry Bass Drilling, first vice president; Virginia Dupies, Continental Supply, president; Marguerite Reavis, Seaboard Oil of Delaware, second vice president. Second row, Frankie Frensley, W. P. Luse, treasurer; Helen Mourning, Reagan J. Caraway, recording secretary, and Josephine Buell, Floyd C. Ramsey, corresponding secretary.

Third Quarter Allotments For Steel Not Necessary

The Petroleum Administration for Defense has announced that it will not be necessary for the oil and gas operators to make third-quarter allotments of casing, tubing, or drill pipe.

Noting that the statutory authority for Government controls over oil-country tubular goods and other materials expire on June 30, Ed Warren, deputy administrator, said that PAD will not make allotments beyond the second quarter unless extension of controls is authorized and unless administrative plans are made to continue allotments after the end of the quarter.

Hence it is unnecessary now for oil and gas operators to submit requests for third-quarter allotments on Forms PAD-17 or PAD-17DP, Warren said. If it should be necessary later to process such applications for the third quarter, adequate notice and opportunity for filing will be given.

September World Oil Output Ran More Than August

World crude petroleum production during September averaged a record 12,549,000 bbl daily, compared to the daily average rate of 12,178,000 during August, according to the U. S. Bureau of Mines. Record daily average production rates of 6,518,000, 198,000 and 491,000 bbl occurred in September in the United States, Canada, and Iraq respectively. Venezuelan crude production, averaging 1,718,000 bbl daily, was slightly under the August rate.

Crude imports into western Europe averaged a record 1,503,000 bbl daily during September, compared to 1,363,000 in August, the report stated. All the major crude importing countries of the region increased their daily average crude imports. The September gains in Italy, the Netherlands, and the United Kingdom amounted to 18.0, 22.1, and 3.2 per cent respectively.

Exports of crude from the Middle East (exclusive of shipments to Bahrain) attained a record daily average rate of 1,765,000 bbl during September, compared to 1,619,000 in August. Iraq, on the basis of a partial estimate, shipped 472,000 bbl daily (a record), an 11.6 per cent increase over August.

Total Oil Stocks Set New Record for Week of March 7

Gasoline stocks set a new record for the week ending March 7, with a total of 159,434,000 bbl, an increase of 1,822,000 from the week before, and nearly 6,000,000 bbl above the same period last year. Previous high was 158,816,000 bbl on March 29, 1952.

Total for the week ending March 7 marked a decrease in stocks of 1,675,000 bbl—680,000-bbl decrease in stocks of domestic crude and 995,000-bbl in stocks of foreign crude.

Gas oil and distillate stocks fell 2,549,000 bbl to 65,476,000, but are still almost 12,000,000 bbl above a year ago.

Crude oil production dropped off 81,300 bbl daily during the week, to an average of 6,439,800, not much above a year earlier when the average daily output was 6,420,500. Texas production was down 98,750 bbl daily to 2,840,800, more than 100,000 daily under the same week a year ago.

Conoco Sets Safety Record

Employees of Humble Oil and Refining Company and Humble Pipe Line Company set the best safety record in the history of the companies last year with an accident frequency of only 1.87 disabling injuries per million hours worked.

Humble's all-time low disabling injury rate during the past year was a 41 per cent decrease from 1951, the year the previous best record was established.

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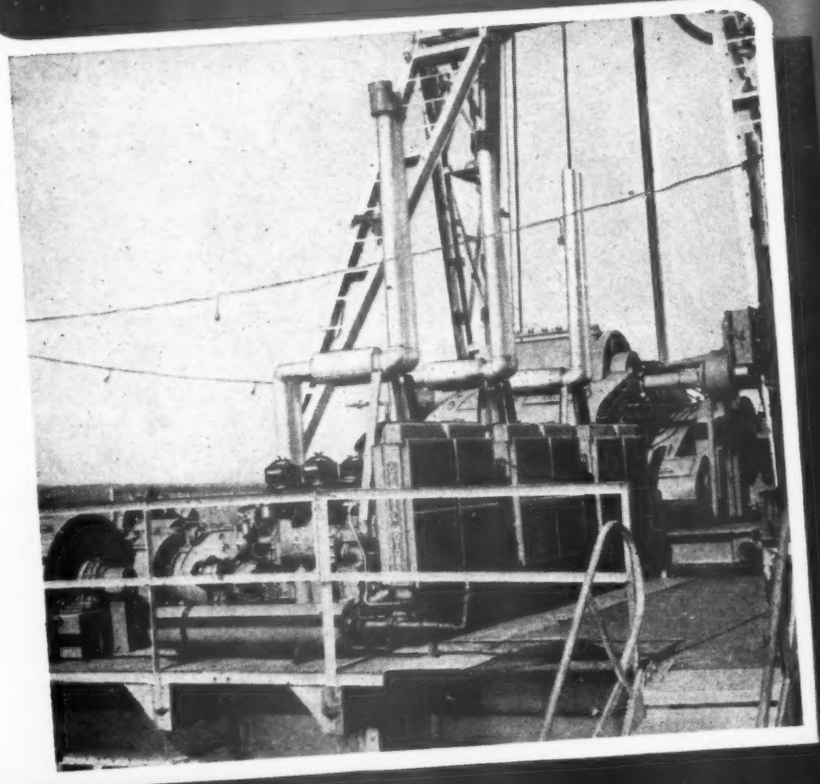
USER: Northern Development Co., of Tioga, N. Dakota, subsidiary of Regent Drilling Co., Edmonton, Alberta.

INSTALLATION: Three GM Diesel "Twin-6" torque converter units driving an Ideal 125 draw works and two Ideal C 350 mud pumps; GM 3-71 Diesel drives a generator set.

PERFORMANCE: Engines have operated 6,000 hours since they were installed, without causing delay or requiring repairs. Tool Pusher Bob Davidson says the engines are compact for their power and provide greater flexibility and better portability.



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Sunray Sets Up New Industrial Relations Office

A new department of industrial relations for Sunray Oil Corporation to be headed by Forney Hutchinson, Jr., as manager has been announced by Sunray's president, W. C. Whaley.

Sunray's industrial relations department will supervise all phases of personnel employment and placement, safety and training programs, and labor relations. The company has more than 2100 employees in the Mid-Continent oil producing states and California.

Hutchinson, who joined the Sunray organization in 1937 as an attorney, has been directing most phases of the company's industrial relations program since June, 1950.

In this connection R. Alvin Summers, formerly superintendent of the company's Oklahoma exploitation district, at Oklahoma City, will be transferred to the Tulsa general offices to be supervisor of the new department's safety and training section, and to assist field supervisors in employee relations matters.

V. L. Smith, formerly assistant Oklahoma district superintendent at Oklahoma City, is being named superintendent of the Oklahoma district by R. E. Foss, vice president and manager of the exploitation department.

Oil Discovery Celebrated

The annual Oil Discovery Day Celebration is being held April 18 in Williston, North Dakota. Guest of honor and principal speaker at Williston's second annual Oil Discovery Day celebration, will be Dr. Robert E. Wilson, chairman of the board, Standard Oil Company.

Ohio Expands Office

Plans for a new addition to The Ohio Oil Company's general office building in Findley, Ohio, which will meet present space requirements and provide for future expansion have been announced by J. C. Donnell II, president.

The three-story brick building, which now is part of the Hardin street wing of the office will be removed and the entire south wing will be built to a height of eight floors, two floors higher than the present main building. An eight-floor wing will also be built along the alley at the rear of the building, thus closing the U-shaped structure formed by the three present wings. The program will require about two years to complete.

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3-5' 3" diameter x 3' face (2 rubber lined and complete with explosive proof drives) (1 carbon steel and complete with splash proof drives) used, and in good condition.

For further details and inspection arrangements please contact: Merck & Co., Inc., Rahway, N. J., Attn: Mr. C. O. Barstow, telephone RA. 7-1200.

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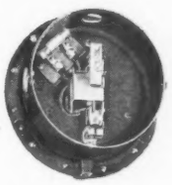

Type PPQ diaphragm differential pressure control operates from minute changes (.03" of water) in the difference between two pressures. Ranges available 6" vac. to 6" press., and 30" vac. to 30" pressure.

Type BB Differential pressure control for high pressures. Opens or closes a switch contact according to a change in the difference between two pressures. Available ranges 60 psi to 2500 psi.

Type DA-21 pressure control opens or closes an electrical circuit upon an increase or decrease of pressure. Can be furnished with many different circuit arrangements. Ranges available 0-14 psi. to 300-2500 psi.

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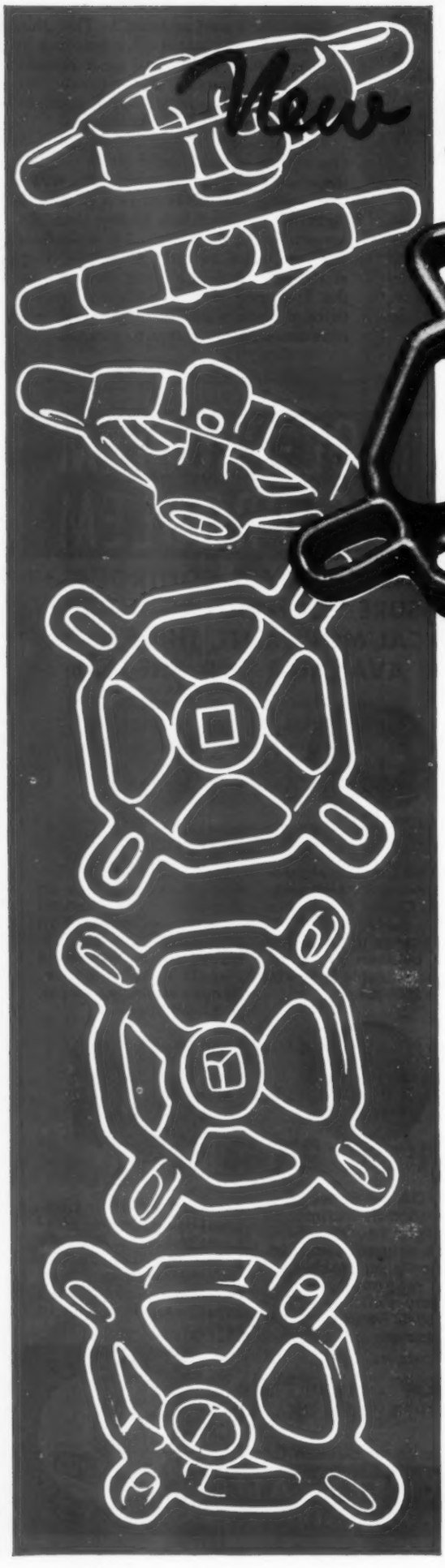

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Rounded lugs provide a firm, comfortable, secure grip, even when the operator's hand is wet or greasy. And the "Non-Slip" Handwheel stays cool —does not transmit excessive heat to the outer rim. Operator's hand cannot touch the top of the valve stem, which may be hot.

Only Lunkenheimer Valves have the new malleable iron "Non-Slip" Handwheel. Ask for a demonstration of its amazing performance. Hear how it will save you money by eliminating one of the most common causes of valve leakage.

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PERSONALS

E. F. Battson, administrative vice president, was elected chairman of the executive committee of the board of directors, Continental Oil Company, at a meeting of the board in New York City.

Chas. A. Perlitz, Jr., vice president, and **Ira H. Cram,** vice president in charge of exploration, were appointed to the newly created positions of senior vice presidents.

Both Perlitz and Cram will continue to make headquarters in Houston, but Battson will establish his offices in New York City.

Battson succeeds George Whitney, who resigned as chairman of the executive committee, but will continue to serve as a member of that committee. Battson, in addition to being chairman of the executive committee, will continue as a vice president of the company.

C. A. Peterson, Pacific Coast area treasury manager for Shell Oil Company in Los Angeles, celebrated his 30th year of service with the company. On this occasion, Peterson was honored with a luncheon in the California Club, where he was presented the traditional diamond-studded Shell emblem by S. F. Bowlby, vice president.

Peterson began his association with Shell in 1923 as a depot clerk in Chino, California. He progressed through various positions with the company, and in 1935 was appointed office manager in Oakland. In 1937 he became assistant general auditor in San Francisco and in 1940 he assumed his present position in Los Angeles as treasury manager.

C. E. Davis has been named Associate Deputy Administrator of the Petroleum Administration for Defense. Davis joined PAD in August 1951, as deputy director of the agency's refining division, becoming director of the division the following month. In 1952, he was appointed Assistant Deputy Administrator in charge of domestic petroleum operations.

Davis came to PAD from the Shell Oil Company, of which he was vice president in charge of refining. He joined Shell in 1917, holding various technical and executive positions in connection with refining.

Donald I. Lawless, manager of exploration for Canadian Bishop Oil, Ltd., has been elected a member of the board of directors of Canadian Bishop Oil, Ltd. Presently stationed in Calgary, Alberta Province, Canada, Lawless has been prominently identified with the activities of Bishop Oil Company, the American parent company, in Mid-Continent fields.

J. W. Hoover was appointed president of the Chevron Oil Company, a wholly-owned subsidiary of the Standard Oil Company of California. In accepting this appointment, Hoover is resigning his post as vice president of the exploration department and director of The California Company, also a wholly-owned subsidiary of Standard Oil Company of California.

Hoover began work in 1927 in Texas and advanced steadily in the exploration departments of various Standard of California subsidiaries through such positions as superintendent of geophysics, division exploration superintendent, and most recently, vice president of the exploration department of The California Company.

The California Company has announced that exploration activities hereafter will be conducted by two departments, the exploration department and the land department. **L. I. Brown** has been appointed to the position of manager of the exploration department, and **T. C. Nugent,** vice president, will be in charge of the land department.

E. F. Bullard, president of Stanolind Oil and Gas Company, Tulsa, Oklahoma, was elected to the board of directors of the First National Bank and Trust Company, at the March board meeting, R. Otis McClintock, president, announced.

Bullard, president of Stanolind since 1945, has been a nationally known oil executive for many years. He began his career in 1921 as a geologist and joined Dixie Oil Company in 1929.

Three years later he was made director-in-charge of exploration for Stanolind and was elected successively vice president, director, executive vice president, and president of the company.

Earl D. Wallace, who recently resigned as president and a director of Sohio Petroleum Company and as a vice president and director of The Standard Oil Company (Ohio) has become a consultant to Dillon, Read and Company, Inc., on oil and gas matters.

Samuel A. McKee, chief of the lubrication section of the National Bureau of Standards, retired recently after 32 years service with NBS. McKee is a prominent specialist in the field of lubrication. As chief of the NBS Lubrication Section he has been responsible for the Bureau's basic and applied research in engines and lubrication, including testing of lubricants and liquid fuels, research on viscosity and maintenance of viscosity standards.

McKee joined the NBS staff in 1921 as an assistant research mechanical engineer engaged on the lubrication of bearings, gears, and other machinery. He rose in the NBS staff until he became acting chief of the Lubrication Section in 1945. He became Section Chief in 1947.

Hollis D. Immick, former vice president, has been named president of Inter-State Oil, Kansas City, Kansas, upon the death of C. A. Shephard, former president. Immick has been with the company as vice president since 1947 and a director since 1940. A graduate of Yale University, he was president of the Immick Company, a general contracting organization prior to joining Inter-State.

Other new officers include: **Robert A. Nylander,** treasurer, and **Mrs. C. A. Shephard,** secretary. Nylander was former purchasing agent and treasurer.

Claude V. Barrow, oil editor of the *Daily Oklahoman,* was honored at a Chamber of Commerce Forum in Oklahoma City recently. Roy Turner, oil man, and former governor, presented Barrow with a scroll, "in appreciation for your immeasurable service as a journalist to the oil and gas industry . . . unsullied by base motives of self-interest."

Rear Admiral H. B. Miller (U. S. N., Ret.) has resumed his duties as executive director of the Oil Industry Information Committee, and director of the Department of Information of the American Petroleum Institute.

He had been on leave-of-absence for one year to serve as president of the National Committee For a Free Europe —an American organization dedicated to the fight against Communism. Concurrent with Miller's return to OIIC, Edwin W. Esmay, who had served as acting director returned to Standard Jersey.

Lyman L. Bryan has been named director of information in the Washington, D. C., office of the Independent Petroleum Association of America, it was announced by Charlton H. Lyons, president of the association.

Prior to this appointment, Bryan had been in public relations work with the Pan American Refining Corporation, Texas City, Texas, and more recently with the National Cotton Council. He is a graduate of the school of journalism at the University of Oklahoma.

M. E. Spaght and **A. J. Galloway** have been elected to the board of directors of Shell Oil Company. Both Shell executives will have headquarters in New York.

Spaght, formerly president of Shell Development Company, the research affiliate of Shell Oil, was recently appointed executive vice president of Shell Oil. Galloway is vice president in charge of the company's exploration and production activities in the United States and Canada.

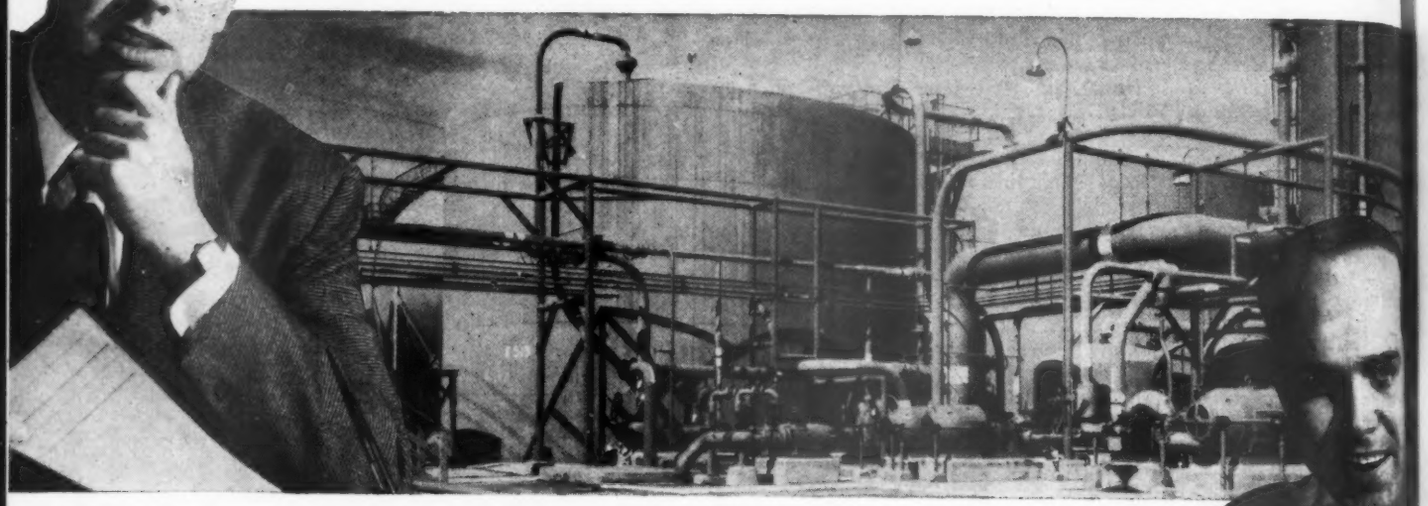
Earl W. Grabhorn has been appointed as a district representative of the Oil Industry Information Committee in the Gulf-Southwest district. Grabhorn will become the second district representative in the Dallas office of the OIIC. He fills the place vacated by **W. T. Lynde** who was promoted last August to senior representative for the district which embraces Texas, New Mexico, Louisiana, Mississippi, Alabama, and Arkansas.

Grabhorn was graduated from Evansville College, Evansville, Indiana, in 1942 and after serving three years in the Navy returned to Indiana University to get his Masters Degree.

E. B. Clark has been named president of the North Texas Oil and Gas Association. Election was held at the group's board of directors at a meeting prior to the organization's 23rd annual meeting in Wichita Falls, Texas, recently.

Other officers include: **Charles N. Prothro,** first vice president; **D. C. Norwood,** second vice president, and **Fred Sehmann,** executive vice president.

When you're up against a tubing problem.



Tubing Headquarters

can help you solve it!

WHEN the question of tubing comes up for a new installation or for replacement, don't cross your fingers and "take a shot in the dark" hoping that your choice will prove the answer to your needs. Play safe! Come to Tubing Headquarters. Tell National Tube what conditions are at your plant. The chances are that we have already helped other refineries handle similar situations . . . *and successfully*. In fact our files are filled with case histories, the results of laboratory tests, and actual field observations involving National Seamless Steel Pipe and Tubing under practically every condition of temperature, pressure, corrosion and exposure.

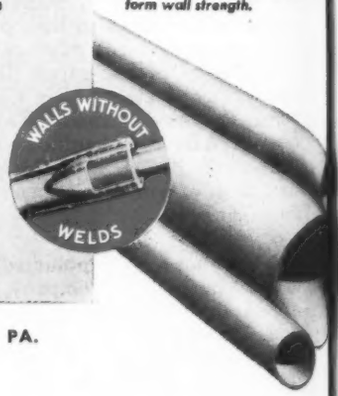
Out of this research and study have come important developments in tubing steel which enable National Tube to offer you seamless steel tubing, condenser tubes, heat exchanger tubes, and refinery piping in *24 different analyses*. Each of these 24 different analyses has been performance-proved to meet the specific conditions of corrosion and oxidation for which it is recommended.

We invite you to bring your problems to National Tube. Our tubing specialists will work closely with your own engineers to see that you get *just the right* tubes and piping for your particular requirements.

NATIONAL TUBE offers you
Seamless Steel Still Tubes
Condenser Tubes
Heat Exchanger Tubes
Refinery Piping
in 24 DIFFERENT ANALYSES

Carbon	7 Cr, ½ Mo
Carbon, ½ Mo	8 Cr, ½ Mo
½ Cr, ½ Mo	8 Cr, 1 Mo
1 Cr, ½ Mo	9 Cr, 1 Mo
1¼ Cr, ½ Mo	12 Cr, Al
2 Cr, ½ Mo	17 Cr
2¼ Cr, 1 Mo	27 Cr
2½ Cr, ½ Mo, ¾ Si	18-8
3 Cr, 1 Mo	18-8 Ti
5 Cr, ½ Mo	18-8 Cb
5 Cr, ½ Mo, 1½ Si	18-8 Mo
5 Cr, ½ Mo, Ti	25-20

All National Seamless Tubes are pierced from a solid billet of high-quality steel. This is the seamless manufacturing method that removes all doubt concerning uniform wall strength.



NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

DEATHS

Cervantes A. (Van) Shephard, president of Inter-State Oil, Kansas City, Kansas, was killed recently in an automobile accident. Shephard attended the University of Missouri and was a graduate of Kansas City Junior College. He was active in the petroleum industry, and a charter member and director of Independent Oil Compounders Association.

George E. Dorsey, geologist with Socony-Vacuum Oil Company, died of a heart attack in New York City, March 7. Upon his graduation from Johns Hopkins University in 1914, Dorsey joined the Maryland Geological Survey and U. S. Geological Survey. Later he was chief subsurface geologist for Carter Oil Company. In 1926 he joined Magnolia Petroleum Company and moved to Dallas, where he remained until 1934 when he transferred to New York City as chief geologist in charge of producing operations of Socony-Vacuum. He became a consultant from 1937 until 1944, when he re-joined Socony-Vacuum.

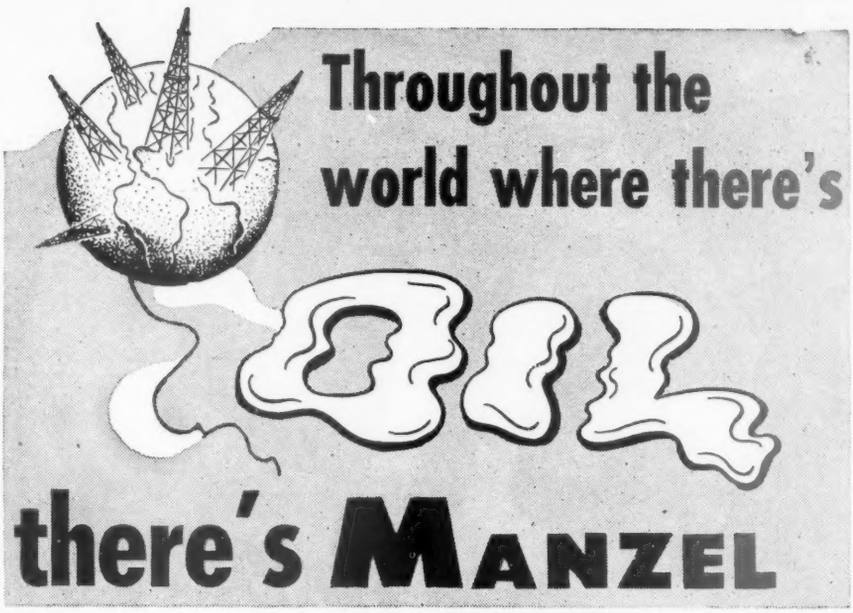
George R. Prout, vice president and general manager, nucleonic and atomic projects, General Electric Corporation, died March 8. A graduate of Massachusetts Institute of Technology, Prout first became associated with GE in 1922 on a part time basis. He obtained his degree from MIT in 1923 and came to Dallas the next year as manager of the industrial department, in which position he was associated with the petroleum industry. In 1939 he went to Bloomfield, New Jersey, in charge of the air conditioning division, and later to Richland, Washington, where he headed up the Hanford atomic energy plant, a government project. After three years as head of this project he transferred to Schenectady, New York, last year where he accepted the position he held at time of his death. Prout was 53 years of age.

Edward Fontaine Warren, Jr., geological scout for the California Company, died March 17 in a Jackson, Mississippi, hospital. He was 55 years old. A graduate of Castle Heights Military Academy, Lebanon, Tennessee, and the University of Mississippi, Warren was a member of the American Association of Petroleum Geologists. He had been actively interested in the oil industry for many years. He was a native of Yazoo City, Mississippi, and had lived in Jackson for the past 10 years.

Thomas Logan Weaver died in Fort Worth, Texas, on March 5. He was 79 years old. A pioneer in the oil industry, Weaver and a brother, the late T. B. Weaver, organized Weaver Brothers Drilling Contractors and drilled some of the first wells in Ranger and Cisco fields. Company was dissolved in 1938.

Richard B. Pedersen, formerly a sales engineer for Continental Oil Company in Oklahoma, died recently in Winslow, Washington. He was 57 years of age.

Claude R. Page, shop superintendent for Lone Star Gas Company, died March 6. He was 55 years of age.



Lubricators

Manufacturers serving the world-wide petroleum industry standardize on Manzel Force Feed Lubricators to make sure users of their machinery will receive long, economical, trouble-free service. Manzels supply all wearing parts with just enough of the right lubricating oil...cut labor costs to a minimum...reduce oil consumption to half that of hand feeding...prevent costly breakdowns.

Chemical Feeders

In pipe line, oil tank and bottom hole treatment, the various chemical compounds are automatically introduced in accurately measured quantities by Manzel Chemical Feeders. Sturdily built and simply designed, these feeders have an unsurpassed record for dependable, trouble-free operation.

•

Be sure to specify *Manzel* on your next installation...and write for helpful information about obtaining Manzels for your present equipment.

See Our Exhibit
OIL SHOW
TULSA MAY 14-23

Manzel

291 Babcock Street
Buffalo 10, New York

To obtain more information on products advertised see page E-59

STOP Ring Breakage

...with COOK Pressure-Energized 124 Rings

Cook discovered the many causes that promote ring breakage by extensive research in the field of practical operation which included electronically indicating most makes of engines. Of all ring types tested, Cook 124 ring proved its superiority time and again. It has eliminated ring breakage, and other problems in many leading Diesel plants. But write for the full story — learn why it will pay you to install Cook "job-engineered" piston rings.

C. Lee Cook Mfg. Co., Incorporated, Louisville, Ky.
Branch offices in Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, New Orleans, New York, San Francisco and Tulsa.

COOK

PISTON RINGS

. . . SEALING PRESSURES SINCE 1888 . . .

TON MILES

4½-in. drill pipe — 16.6 lb. per foot

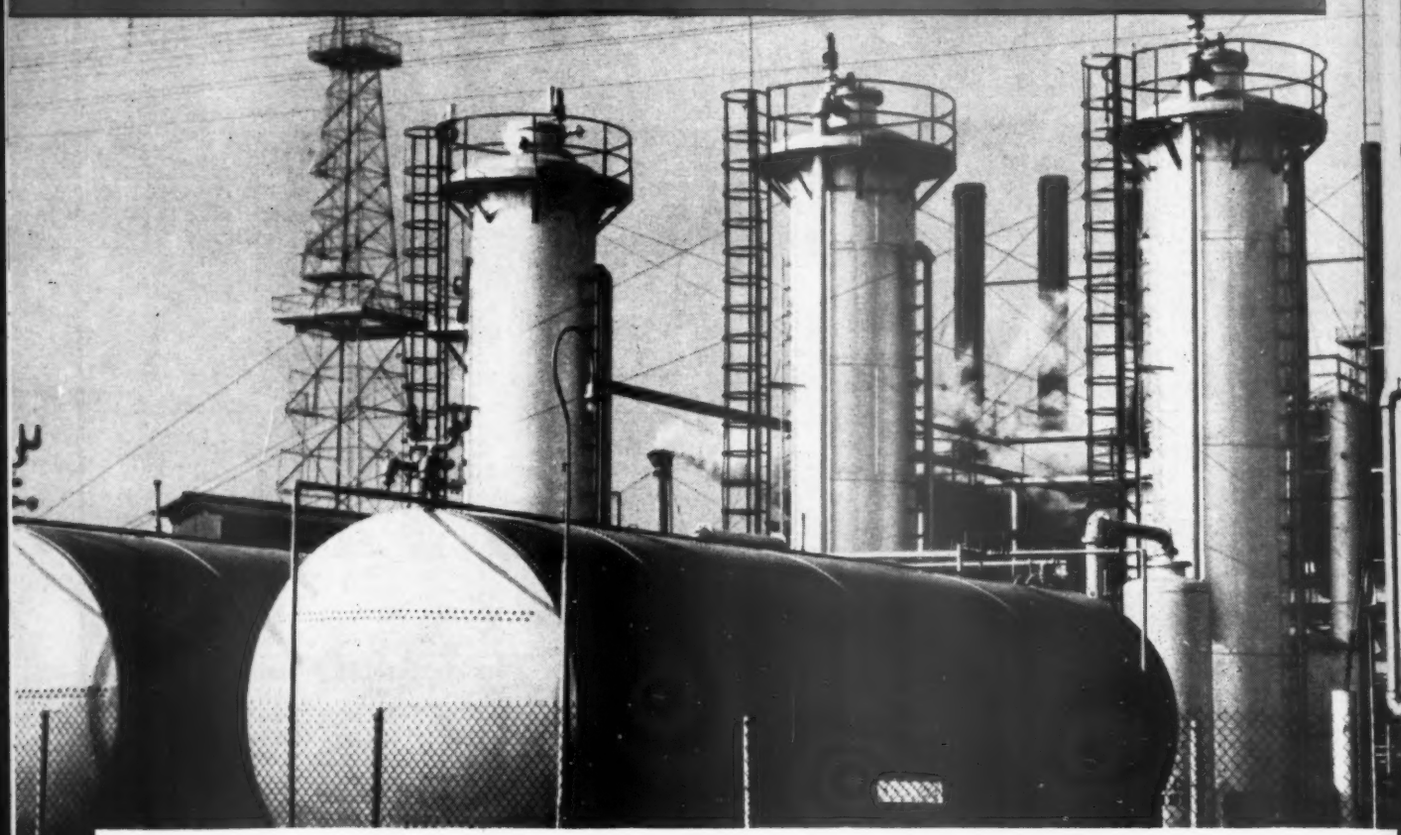
DEPTH	0	100	200	300	400	500	600	700	800	900
40,000 lb EXCESS WEIGHT										
0	0	2	3	5	6	8	10	11	13	15
1000	17	18	20	22	24	26	28	30	32	34
2000	36	38	40	43	45	47	49	52	54	56
3000	59	61	63	66	68	71	73	76	79	81
4000	84	86	89	92	95	98	100	103	106	109
5000	112	115	118	121	124	127	130	133	136	140
6000	143	146	149	153	156	159	163	166	169	173
7000	177	180	184	187	191	194	198	202	206	209
8000	213	217	221	225	229	232	236	240	244	248
9000	252	257	261	265	269	273	278	282	286	290
10000	295	299	304	308	312	317	321	326	331	335
11000	340	344	349	354	359	363	368	373	378	383
12000	387	393	398	403	408	413	418	423	428	433
13000	438	444	449	454	460	465	470	476	481	487
14000	492	498	503	509	514	520	526	531	537	543
15000	549	554	560	566	572	578	584	590	596	602
16000	608	614	620	626	632	639	645	651	657	664
17000	670	676	683	689	696	702	709	715	722	728
18000	735	742	748	755	762	768	775	782	789	796
19000	803	810	817	824	831	838	845	852	859	866
45,000 lb EXCESS WEIGHT										
0	0	2	4	5	7	9	11	13	15	17
1000	19	21	23	25	27	29	31	34	36	38
2000	40	42	45	47	49	52	54	57	59	62
3000	64	67	70	72	75	78	80	83	86	89
4000	91	94	97	100	103	106	109	112	115	118
5000	121	125	128	131	134	137	141	144	147	151
6000	155	158	161	165	168	172	175	179	182	186
7000	190	194	197	201	205	209	213	216	220	224
8000	228	232	236	240	244	249	253	257	261	265
9000	270	274	278	283	287	291	296	300	305	309
10000	313	318	323	328	332	337	342	346	351	356
11000	361	366	370	375	380	385	390	395	400	405
12000	411	416	421	426	431	437	442	447	452	458
13000	463	469	474	480	485	491	496	502	507	513
14000	519	524	530	536	542	548	553	559	565	571
15000	577	583	589	595	601	607	613	620	626	632
16000	638	644	651	657	663	670	676	683	689	696
17000	702	709	715	723	729	735	742	749	755	762
18000	769	776	783	790	797	804	811	818	825	832
19000	839	846	853	860	867	875	882	889	897	904
50,000 lb EXCESS WEIGHT										
0	0	2	4	6	8	10	12	14	16	18
1000	20	22	25	27	30	32	34	37	39	41
2000	44	46	49	51	54	57	59	62	65	67
3000	70	73	76	78	81	84	87	90	93	96
4000	99	102	105	108	111	115	118	121	124	128
5000	131	134	138	141	144	148	151	155	158	162
6000	166	169	173	177	180	184	188	192	195	199
7000	203	207	211	215	219	223	227	231	235	239
8000	244	248	252	256	261	265	269	274	278	282
9000	287	291	296	300	305	309	314	319	323	328
10000	333	338	342	347	352	357	362	367	372	377
11000	382	387	392	397	402	407	412	418	423	428
12000	434	439	444	450	455	460	466	471	477	483
13000	488	494	499	505	511	516	522	528	534	540
14000	546	551	557	563	569	575	581	587	594	600
15000	606	612	618	624	631	637	643	650	656	663
16000	669	675	682	688	695	702	708	715	722	728
17000	735	742	748	755	762	769	776	783	790	797
18000	803	810	817	824	831	839	845	853	860	867
19000	875	882	889	897	904	911	919	926	934	941

EXAMPLE: Ton miles per round trip at depth of 12,500 ft with 4½-in., 16.6 lb. drill pipe and 45,000 lb excess weight = 437.

Courtesy Wickwire Rope, The Colorado Fuel and Iron Corporation

IN THE PETROLEUM INDUSTRY

There's more to CORROSION than meets the eye



Sometimes VISIBLE...Often HIDDEN...Corrosion Strikes Everywhere

This year, the Petroleum Industry will pay millions of dollars for needless losses created by corrosion... *yet much of this corrosion may never be discovered* until it's too late to protect—and time to pay!

Corrosion is readily detected when it appears as rust layers or failing paint on exposed surfaces. But, by far, the major costs of corrosion come from hidden areas—where only minute inspections and constant care can prevent costly failures.

YOU LOSE IN A "WAITING GAME"

Don't wait for rust or other visible signs to appear. Visible or hidden, corrosion will destroy costly equipment... halt production... cause unnecessary maintenance shutdowns... and contaminate valuable products. Thus, corrosion dips deep into your profits as it creates needless losses totaling thousands of dollars.

YOU CAN PREVENT NEEDLESS WASTE

Check your tanks, piping and equipment for corrosion's presence. Double-check areas that are vulnerable to *hidden corrosion.* If you would like help, an AMERCOAT Field Engineer will gladly assist you in making a thorough analysis. There is no obligation.

What is AMERCOAT?

AMERCOAT is a method of corrosion control. Not just a single product, but a complete LINE of coatings, individually formulated to solve or control specific industrial corrosion problems.

FOLLOW THE LINE OF *most* RESISTANCE... PROTECT WITH *Amercoat!*

AMERCOAT CORPORATION

4809 FIRESTONE BLVD., SOUTH GATE, CALIFORNIA

CHICAGO, ILL. NEWARK, N. J. JACKSONVILLE, FLA. DALLAS, TEX.

TON MILES — 4½-in. drill pipe — 16.6 lb. per foot

55,000 lb EXCESS WEIGHT

DEPTH	0	100	200	300	400	500	600	700	800	900
0	0	2	4	6	9	11	13	15	17	20
1000	22	25	27	30	32	35	37	40	42	45
2000	48	50	53	55	58	61	64	67	70	73
3000	76	79	82	85	88	91	94	97	100	103
4000	107	110	113	116	120	123	127	130	134	137
5000	140	144	147	151	155	158	162	166	169	173
6000	177	181	185	188	192	196	200	204	208	212
7000	216	220	225	229	233	237	241	246	250	254
8000	259	263	267	272	276	281	285	290	294	299
9000	304	308	313	318	322	327	332	337	342	347
10000	352	357	362	367	372	377	382	387	392	397
11000	402	408	413	418	423	429	434	440	445	451
12000	456	462	467	473	478	484	490	495	501	507
13000	512	518	524	530	536	542	548	554	560	566
14000	572	578	584	590	596	603	609	615	621	628
15000	634	640	647	653	660	666	673	679	686	692
16000	699	705	712	719	726	732	739	746	753	760
17000	767	774	781	788	795	802	809	816	823	830
18000	837	845	852	859	866	874	881	888	896	903
19000	911	918	926	933	941	949	956	964	972	979

60,000 lb EXCESS WEIGHT

0	0	2	5	7	9	12	14	17	19	22
1000	24	27	29	32	35	38	40	43	46	49
2000	51	54	57	60	63	66	69	72	75	78
3000	81	85	88	91	94	97	101	104	107	111
4000	114	118	121	125	128	132	135	139	143	146
5000	150	154	157	161	165	169	173	177	180	184
6000	188	192	196	200	205	209	213	217	221	225
7000	230	234	238	243	247	251	256	260	265	269
8000	274	278	283	288	292	297	302	306	311	316
9000	321	326	331	336	340	345	350	355	361	366
10000	371	376	381	386	391	397	402	407	413	418
11000	423	429	434	440	445	451	456	462	468	473
12000	479	485	490	496	502	508	514	520	525	531
13000	537	543	549	555	562	568	574	580	586	592
14000	599	605	611	618	624	630	637	643	650	656
15000	663	669	676	682	689	696	702	709	716	723
16000	730	736	743	750	757	764	771	778	785	792
17000	799	806	814	821	828	835	843	850	857	865
18000	871	879	886	894	901	909	916	924	931	939
19000	947	954	962	970	978	985	994	1001	1009	1017

EXAMPLE: Ton miles per round trip at depth of 12,500 ft with 4½-in., 16.6 lb drill pipe and 55,000 lb excess weight = 484.

TON MILES — 4½-in. drill pipe — 18.1 lb. per foot

15,000 lb EXCESS WEIGHT

0	0	1	1	2	3	3	4	5	6	6
1000	7	8	9	10	11	12	13	14	15	17
2000	18	19	20	21	23	24	25	27	28	30
3000	31	33	34	36	37	39	41	42	44	46
4000	48	50	51	53	55	57	59	61	63	65
5000	67	69	72	74	76	78	80	83	85	88
6000	90	92	95	97	100	102	105	107	110	113
7000	116	118	121	124	127	129	132	135	138	141
8000	144	147	150	153	157	160	163	166	169	173
9000	176	179	183	186	189	193	196	200	204	207
10000	211	214	218	222	226	229	233	237	241	245
11000	249	253	256	261	265	269	273	277	281	285
12000	289	294	298	302	307	311	315	320	324	329
13000	333	338	343	347	352	357	361	366	371	376
14000	380	385	390	395	400	405	410	415	420	425
15000	430	436	441	446	451	457	462	467	473	478
16000	484	489	494	500	506	511	517	523	528	534
17000	540	546	551	557	563	569	575	581	587	593
18000	599	605	611	617	623	630	636	642	648	655
19000	661	667	674	680	687	693	700	706	713	720

EXAMPLE: Ton miles per round trip at depth of 12,500 ft with 4½-in., 18.1 lb drill pipe and 15,000 lb excess weight = 311.

Courtesy Wickwire Rope, The Colorado Fuel and Iron Corporation

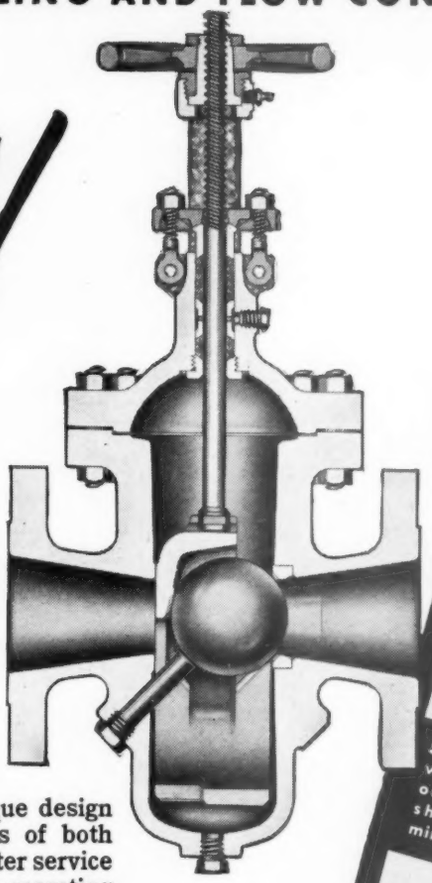
FOR SEVERE THROTTLING AND FLOW CONTROL SERVICES . . .

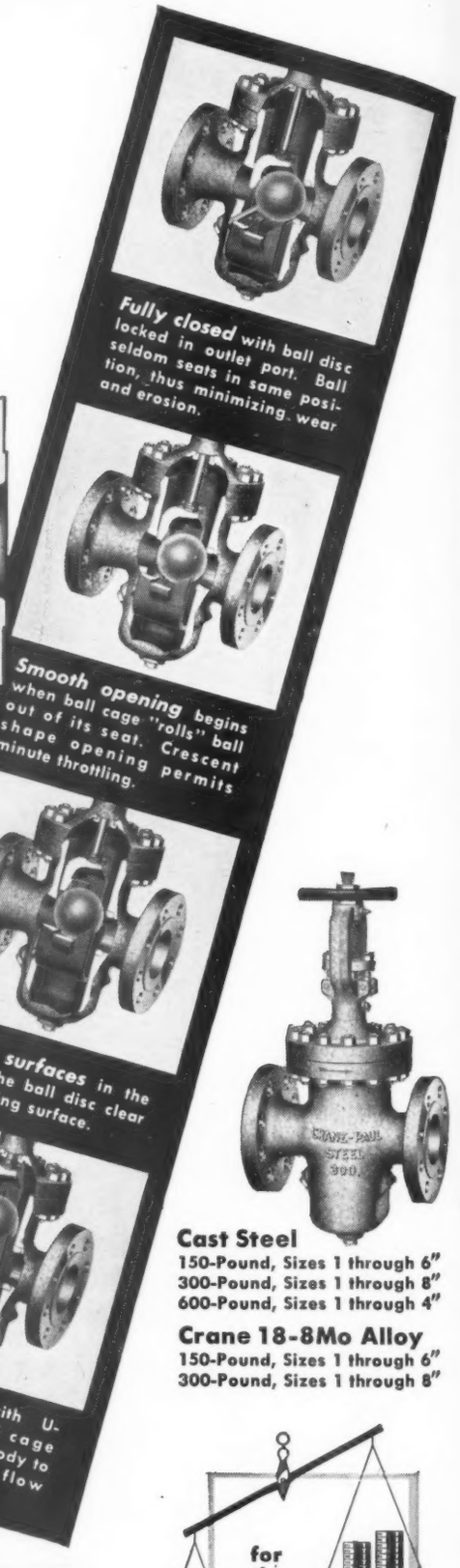
NEW

CRANE-PAUL
Venturi-Ball
VALVES

(Patented and Patents Pending)

CAST STEEL OR CRANE 18-8Mo ALLOY
Outside Screw and Yoke—Flanged. Available with sliding stem for assembly with power operators.




Fully closed with ball disc locked in outlet port. Ball seldom seats in same position, thus minimizing wear and erosion.
Smooth opening begins when ball cage "rolls" ball out of its seat. Crescent shape opening permits minute throttling.
Inclined surfaces in the cage lift the ball disc clear of the seating surface.
Fully opened with U-shaped bottom of cage bridging the gap in body to form a continuous flow passage.

Meet the Crane-Paul Valve—a unique design that combines desirable advantages of both gate and globe valves. It provides better service and longer life under more rigorous operating conditions than such valves normally stand. These features include—

Exceptionally accurate throttling with a minimum of wear and erosion, resulting in long-lived seating surfaces.

Straight-through, non-turbulent flow—with pressure drop characteristics approaching those of venturi-type gate valves.

Smooth, easy response throughout the entire range of operation.

Completely tight shut-off.

Heart of this new Crane-Paul Valve is a precision-ground ball disc which rides loosely in a cage direct-connected to the valve stem. In operation, the ball is moved to and from the center of flow and rolls into and out of the body seat. At no time during valve operation does the ball spin or chatter, even in closely throttled positions. It revolves just enough to provide a new seating surface each cycle. In the closed position, part of the ball actually protrudes into the outlet port where it is tightly seated by the wedging action of the ball cage.

Literature Sent on Request

Full information on this new Crane-Paul Valve is in your Crane 53 Catalog. Literature is available from your Crane Representative or on request to address below.

Cast Steel
150-Pound, Sizes 1 through 6"
300-Pound, Sizes 1 through 8"
600-Pound, Sizes 1 through 4"

Crane 18-8Mo Alloy
150-Pound, Sizes 1 through 6"
300-Pound, Sizes 1 through 8"

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

TON MILES

4½-in. drill pipe — 18.1 lb. per foot

20,000 lb EXCESS WEIGHT

DEPTH	0	100	200	300	400	500	600	700	800	900
0	0	1	2	2	3	4	5	6	7	8
1000	9	10	11	13	14	15	16	17	19	20
2000	22	23	24	26	27	29	30	32	34	35
3000	37	39	40	42	44	46	48	49	51	53
4000	55	57	59	61	63	66	68	70	72	74
5000	77	79	81	84	86	89	91	94	96	99
6000	101	104	106	109	112	115	117	120	123	126
7000	129	132	135	138	141	143	147	150	153	156
8000	159	163	166	169	172	176	179	183	186	189
9000	193	196	200	204	207	211	215	218	222	226
10000	230	233	237	241	245	249	253	257	261	265
11000	269	274	278	282	286	290	295	299	303	308
12000	312	317	321	326	330	335	339	344	349	353
13000	358	363	368	372	377	382	387	392	397	402
14000	407	412	417	422	427	433	438	443	446	454
15000	459	464	470	475	481	486	492	497	503	508
16000	514	520	525	531	537	542	548	554	560	566
17000	572	578	584	590	596	602	608	614	621	627
18000	633	639	646	652	658	665	671	678	684	691
19000	697	704	710	717	724	730	737	744	751	757

25,000 lb EXCESS WEIGHT

0	0	1	2	3	4	5	6	7	9	10
1000	11	12	14	15	16	18	19	21	22	24
2000	25	27	29	30	32	34	35	37	39	41
3000	43	44	46	48	50	52	54	56	59	61
4000	63	65	67	70	72	74	76	79	81	84
5000	86	89	91	94	96	99	102	104	107	110
6000	113	115	118	121	124	127	130	133	136	139
7000	142	145	148	151	155	158	161	164	168	171
8000	175	178	182	185	188	192	195	199	203	206
9000	211	214	217	221	225	229	233	237	241	245
10000	249	253	257	261	265	269	273	277	282	286
11000	290	295	299	303	308	312	317	321	326	330
12000	335	340	344	349	354	358	363	368	373	378
13000	383	388	393	398	403	408	413	418	423	428
14000	433	439	444	449	455	460	465	471	476	482
15000	487	493	498	504	510	515	521	527	533	538
16000	544	550	556	562	568	574	580	586	592	598
17000	604	610	616	623	629	635	641	648	654	661
18000	667	674	680	686	693	700	706	713	720	726
19000	733	740	747	754	760	767	774	781	788	795

30,000 lb EXCESS WEIGHT

0	0	1	2	4	5	6	7	9	10	12
1000	13	15	16	18	19	21	22	24	26	27
2000	29	31	33	35	36	38	40	42	44	46
3000	48	50	52	55	57	59	61	63	66	68
4000	70	73	75	78	80	83	85	88	90	93
5000	96	98	101	104	107	109	112	115	118	121
6000	124	127	130	133	136	139	142	146	149	152
7000	155	159	162	165	169	172	176	179	182	186
8000	190	193	197	201	204	208	212	216	219	223
9000	227	231	235	239	243	247	251	255	259	263
10000	268	272	276	280	285	289	293	298	302	307
11000	311	316	320	325	329	334	339	343	348	353
12000	358	362	367	372	377	382	387	392	397	402
13000	407	412	418	423	428	433	439	444	449	455
14000	460	465	471	476	482	487	493	499	504	510
15000	516	521	527	533	539	545	551	557	563	568
16000	575	581	587	593	599	605	611	617	624	630
17000	636	643	649	656	662	668	675	681	688	695
18000	701	708	715	721	728	735	742	748	755	762
19000	769	776	783	790	797	804	811	818	826	833

EXAMPLE: Ton miles per round trip at depth of 12,500 ft with 4½-in., 18.1 lb drill pipe and 25,000 lb excess weight = 358.

Courtesy Wickwire Rope, The Colorado Fuel and Iron Corporation

ANOTHER *Electric Power* CASE HISTORY

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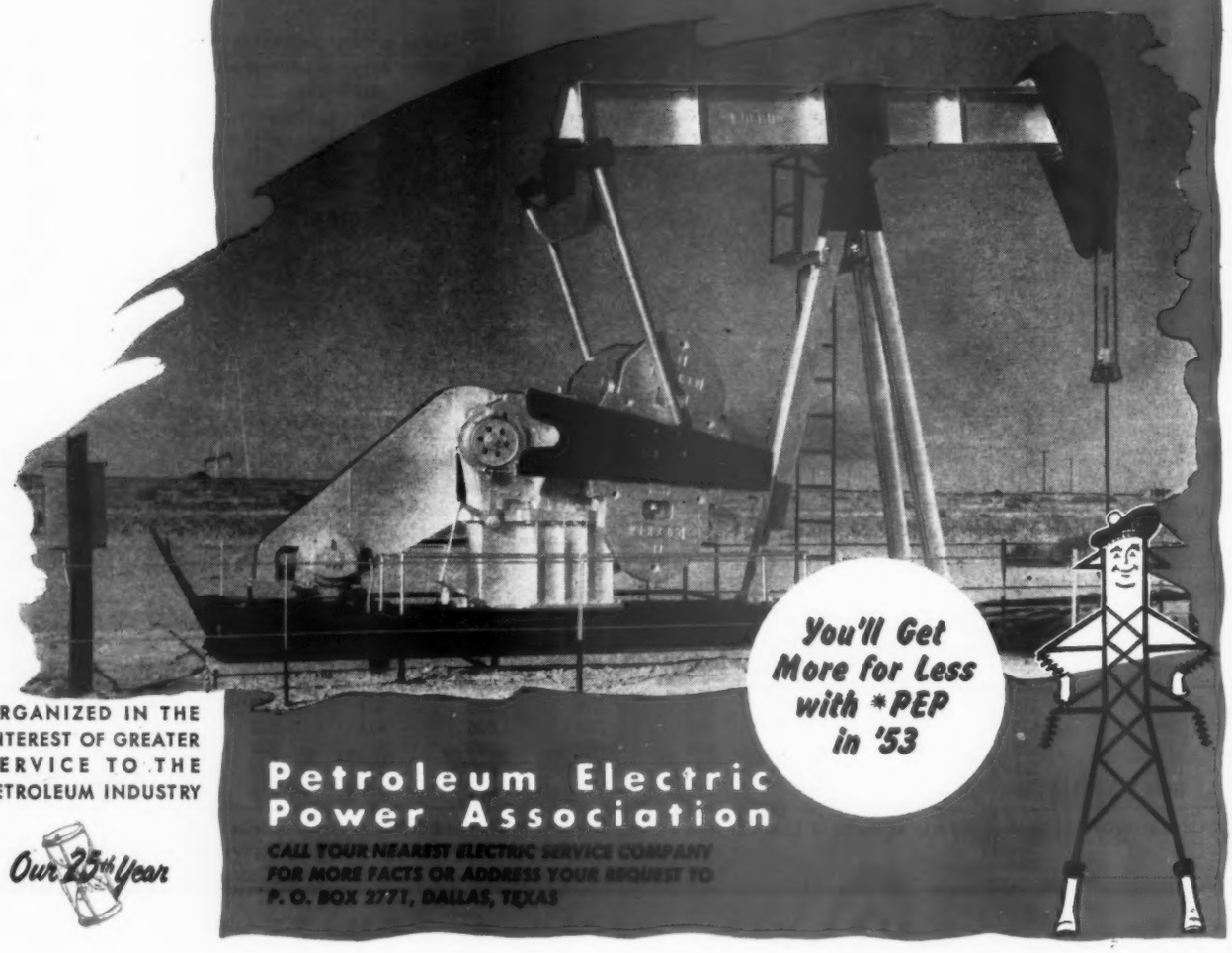

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CHART FOR CORRECTION OF PIPE THREAD TROUBLES*

When threads look like these	Hand Threading		Machine Threading		Do's and Don'ts in Threading
	Inspect for...	Correction	Inspect for...	Correction	
	Dull chasers (Check by inspection.)	Sharpen	Dull chasers	Sharpen	Don't try to work with dull tools. No craftsman can do good work with poor equipment.
	Insufficient lubrication (This not only makes poor threads but damages chasers.)	Use plenty of good oil (Sulphur base threading oil plus little lard oil gives good results.)	Insufficient lubrication	Flood with good oil (Sulphur base plus little lard oil gives good results.)	Don't put new or sharpened chasers in a worn stock, and expect to get first-class results. After the stock is worn out, it should be discarded.
	Improper lead shape (Usually due to improper grinding.)	Grind properly	Improper lead shape	Grind properly	Don't skimp on oil—either in quantity or quality. Good oil pays dividends in better work, and longer die life.
	Excessive or insufficient lead cutting angle	Grind to correct angle	Improper lead cutting angle	Regrind to proper angle	Don't try to use a set of chasers after long use or abuse has impaired its precision. Discarding worn out chasers is sound economy.
	Broken tooth in chaser	Grind out entire tooth	Broken tooth in chaser	Grind out entire tooth	Don't forget to center accurately the die and tighten the thumb screws WITH A WRENCH in hand threading, and don't forget to line up the pipe properly in the grips in machine threading.
	Chasers not set to form true cutting circle	Clean slots—set chasers to true cutting circle—grind chasers to make them of uniform length	Chasers not set to form true cutting circle	Correct setting	Be sure to clear slots of all dirt, gummy oil, chips, etc., when you change chasers. Keeping tools clean lengthens their life.
	Improper lead of chaser	Regrind lead	Improper lead of chaser	Regrind lead	Be sure, when the chasers are reground, that it is done by someone who knows how, or who will accurately follow directions. Wrong grinding can ruin chasers, spoiling a multitude of threads.
	Chasers not tracking properly	Keep slots clean	Chasers not tracking properly	Keep slots clean	
	Chasers not set in due rotation	Correct setting	Chasers not set in due rotation	Correct setting	Be sure that the pipe ends are cut off square and true. Give the die a fair chance, so it can start on straight.
			Carriage travel retarded	Repair carriage	When trouble occurs, check up your equipment carefully. It may be that the trouble is something that a little adjustment will fix. In any case, the difficulty can be corrected with a minimum of cost and lost time.
	Die or chasers not set true	Center die or chasers	Loose chasers (Play in slot lets chasers tilt, increasing clearance.)	New die head	And finally, cut the thread long enough to engage fully the threads in the fitting. A thread like the one illustrated below, is too short to resist mechanical forces caused by expansion and contraction, vibration, and so forth.
	Thumb screws not tight	Tighten screws with wrench			
	Worn-out lead screws	Get new die stock			
	Cuttings or dirt in chaser slots	Keep slots always clean	Worn cam in die head (Check lost motion due to worn cam.)	New die head	
	Pipe ends not square (Die starts on same angle as end cut, and threads diagonally. This trouble often wrongly blamed on "out-of-round" pipe.)	Cut pipe end square to axis of pipe and rethread	Misalignment of die and chuck	Check and re-align	

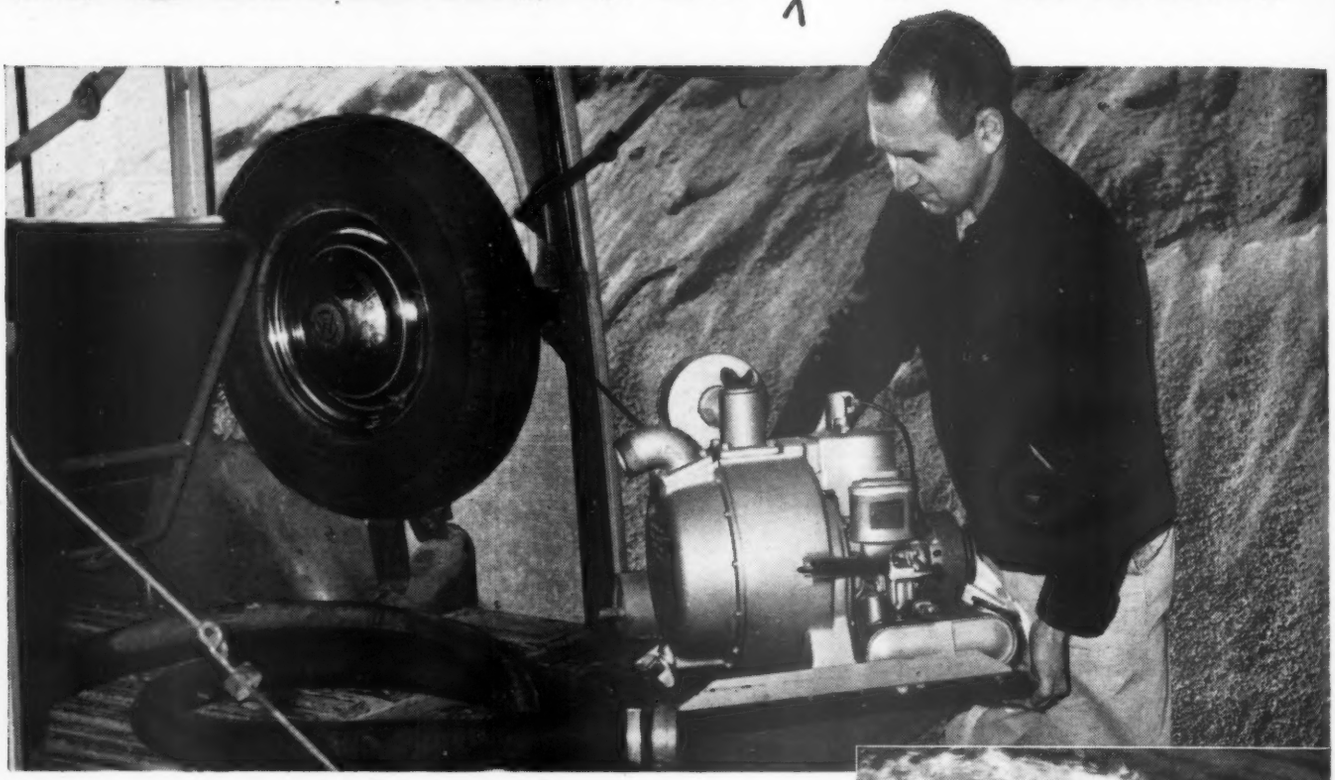
Material supplied by A. M. Byers Company, Pittsburgh, Pennsylvania

*This table may be filed under P 432.4 or 622.21

FOR PIPE LINE CONSTRUCTION

YOU CAN'T BEAT A

HOMELITE Carryable PUMP



IT GETS TO THE JOB *FAST*

IT DOES THE JOB *FAST*

A pipe line goes through some pretty rugged spots. And in those spots,a pumping problem is *really* a problem with nothing but big, bulky pumps available.

Not so with a Homelite. A Homelite will get to a job any place. If a light truck or jeep can't get it there, a man can pick it up and carry it there. You get pumping started fast. What's more, you pump fast. A Homelite handles up to 15,000 gallons per hour without clogging, without trouble. Moreover, it keeps seepage at strainer level automatically. It has a 28 foot suction lift . . . fastest self priming . . . and its built-in gasoline engine is quick starting, weatherproof and dust proof.

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Blowers • Chain Saws

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CORPORATION
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EXCAVATION VOLUMES IN TRENCHES, ETC., CU. YD. PER 1000 LINEAL FT.

Depth of trench, in.	Width of trench, in.																					
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
12	18.5	24.7	30.9	37.0	43.2	49.4	55.6	61.7	67.9	74.1	80.2	86.4	92.6	98.8	105.	111.	117.	123.	130.	136.	142.	148.
14	21.6	28.8	36.0	43.2	50.4	57.6	64.8	72.0	79.2	86.4	93.6	101.	108.	115.	122.	130.	137.	144.	151.	158.	166.	173.
16	24.7	32.9	41.2	49.4	57.6	65.8	74.1	82.3	90.5	98.8	107.	115.	123.	132.	140.	148.	156.	165.	173.	181.	189.	198.
18	27.8	37.0	46.3	55.6	64.8	74.1	83.3	92.6	102.	111.	120.	130.	139.	148.	157.	167.	176.	185.	194.	204.	213.	222.
20	30.9	41.1	51.4	61.7	72.0	82.3	92.6	103.	113.	123.	134.	144.	154.	165.	175.	185.	195.	206.	216.	226.	237.	247.
22	33.9	45.3	56.6	67.9	79.2	90.5	102.	113.	124.	136.	147.	158.	170.	181.	192.	204.	215.	226.	238.	249.	260.	272.
24	37.0	49.4	61.7	74.1	86.4	98.8	111.	123.	136.	148.	160.	173.	185.	198.	210.	222.	235.	247.	259.	272.	284.	296.
26	40.1	53.5	66.9	80.2	93.6	107.	120.	134.	147.	160.	174.	187.	201.	214.	227.	241.	254.	267.	281.	294.	308.	321.
28	43.2	57.6	72.0	86.4	101.	115.	130.	144.	158.	173.	187.	202.	216.	230.	245.	259.	274.	288.	302.	317.	331.	346.
30	46.3	61.7	77.2	92.6	108.	123.	139.	154.	170.	185.	201.	216.	231.	247.	262.	278.	293.	309.	324.	340.	355.	370.
32		65.8	82.3	98.8	115.	132.	148.	165.	181.	198.	214.	230.	247.	263.	280.	296.	313.	329.	346.	362.	379.	395.
34		69.9	87.4	105.	122.	140.	157.	175.	192.	210.	227.	245.	262.	280.	297.	315.	332.	350.	367.	385.	402.	420.
36		74.1	92.6	111.	130.	148.	167.	185.	204.	222.	241.	259.	278.	296.	315.	333.	352.	370.	389.	407.	426.	444.
38		78.2	97.7	117.	137.	156.	176.	195.	215.	235.	254.	274.	293.	313.	332.	352.	371.	391.	410.	430.	450.	469.
40		82.3	103.	123.	144.	165.	185.	206.	226.	247.	267.	288.	309.	329.	350.	370.	391.	412.	432.	453.	473.	494.
42			108.	130.	151.	173.	194.	216.	238.	259.	281.	302.	324.	346.	367.	389.	410.	432.	454.	475.	497.	519.
44			113.	136.	158.	181.	204.	226.	249.	272.	294.	317.	340.	362.	385.	407.	430.	453.	475.	498.	521.	543.
46			118.	142.	166.	189.	213.	237.	260.	284.	308.	331.	355.	379.	402.	426.	450.	473.	497.	521.	544.	568.
48			123.	148.	173.	198.	222.	247.	272.	296.	321.	346.	370.	395.	420.	444.	469.	494.	519.	543.	568.	593.
50			129.	154.	180.	206.	231.	257.	283.	309.	334.	360.	386.	412.	437.	463.	489.	514.	540.	566.	592.	617.
52				160.	187.	214.	241.	267.	294.	321.	348.	374.	401.	428.	455.	481.	508.	535.	562.	588.	615.	642.
54				167.	194.	222.	250.	278.	306.	333.	361.	389.	417.	444.	472.	500.	528.	556.	583.	611.	639.	667.
56				173.	202.	230.	259.	288.	317.	346.	374.	403.	432.	461.	490.	519.	547.	576.	605.	634.	663.	691.
58				179.	209.	239.	268.	298.	328.	358.	388.	418.	448.	477.	507.	537.	567.	597.	627.	656.	686.	716.
60				185.	216.	247.	278.	309.	339.	370.	401.	432.	463.	494.	525.	556.	586.	617.	648.	679.	710.	741.
62					223.	255.	287.	319.	351.	383.	415.	446.	478.	510.	542.	574.	606.	638.	670.	702.	734.	765.
64					230.	263.	296.	329.	362.	395.	428.	461.	494.	527.	560.	593.	626.	658.	691.	724.	757.	790.
66					238.	272.	306.	339.	373.	407.	441.	475.	509.	543.	577.	611.	645.	679.	713.	747.	781.	815.
68					245.	280.	315.	350.	385.	420.	455.	490.	525.	560.	595.	630.	665.	700.	735.	770.	805.	840.
70					252.	288.	324.	360.	396.	432.	468.	504.	540.	576.	612.	648.	684.	720.	756.	792.	828.	864.
72						296.	333.	370.	407.	444.	481.	519.	556.	593.	630.	667.	704.	741.	778.	815.	852.	889.
74						305.	343.	381.	419.	457.	495.	533.	571.	609.	647.	685.	723.	761.	799.	837.	876.	914.
76						313.	352.	391.	430.	469.	508.	547.	586.	626.	665.	704.	743.	782.	821.	860.	899.	938.
78						321.	361.	401.	441.	481.	522.	562.	602.	642.	682.	722.	762.	802.	843.	883.	923.	963.
80						329.	370.	411.	453.	494.	535.	576.	617.	658.	700.	741.	782.	823.	864.	905.	947.	988.
82							380.	422.	464.	506.	548.	591.	633.	675.	717.	759.	801.	844.	886.	928.	970.	1010.
84							389.	432.	475.	518.	562.	605.	648.	691.	735.	778.	821.	864.	907.	951.	994.	1040.
86							398.	442.	487.	531.	575.	619.	664.	708.	752.	796.	841.	885.	929.	973.	1020.	1060.
88							407.	453.	498.	543.	588.	634.	679.	724.	770.	815.	860.	905.	951.	996.	1040.	1090.

Earth and clay increase in bulk ¼ when dug, but subside 1/5 in height and decrease 1/6 in bulk when formed into embankments.
Sand and gravel increase in bulk 1/12 when dug; sand subsides in embankment ¼ in height; gravel from 1/10 to 1/12 according to coarseness. Rock increases ½ of its original bulk when excavated.

APPROXIMATE WEIGHT OF EARTHS, ROCKS, ETC., LB. PER CU. YD.

Sand	3000
Gravel	3000
Mud	2500
Marl	2600
Clay	3100
Chalk	3600
Sandstone	3900
Shale	4000
Quartz	4100
Granite	4200
Trap	4200
Slate	4300

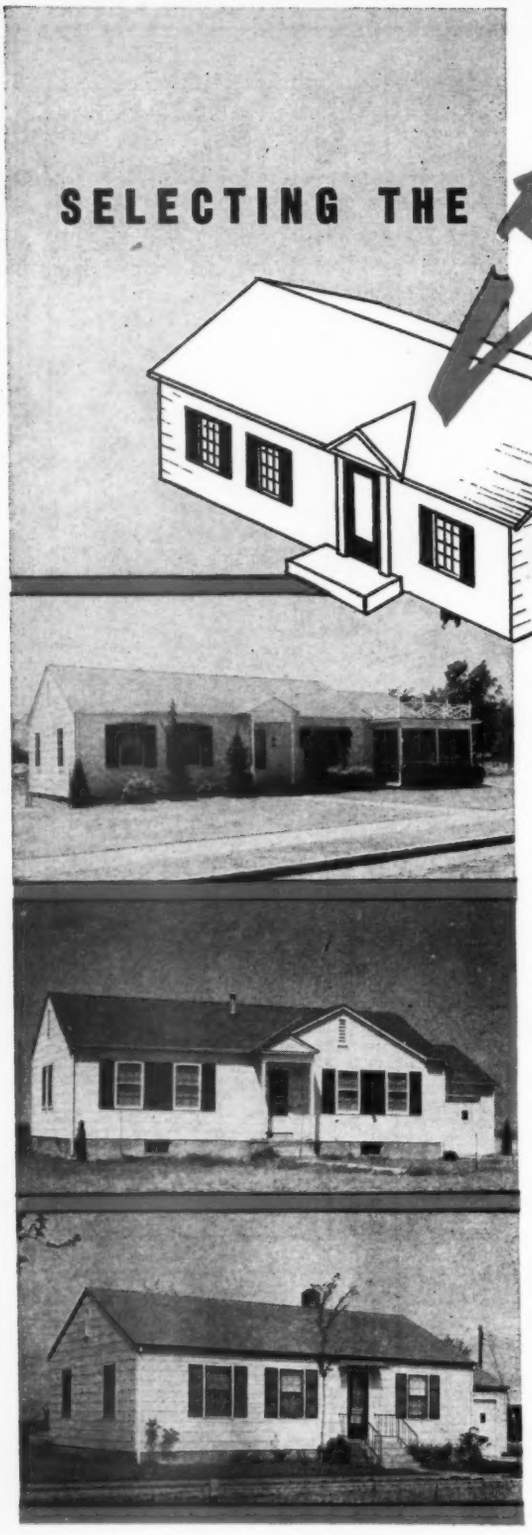
QUANTITIES OF EARTH EQUAL TO A TON (as filled into trucks)

	Volume cu. ft.	Volume cu. yd.
River sand	21	0.78
Pit sand	22	0.81
Coarse gravel	23	0.85
Marl	28	1.04
Stiff clay	28	1.04
Lump chalk	29	1.07
Earth	33	1.22

NATURAL SLOPES OF EARTH

	Avg. angle with horizontal
Gravel	40°
Dry sand	38°
Sand	22°
Vegetable earth	28°
Compact earth	50°
Shingle	39°
Rubble	45°
Clay, well drained	45°
Clay, wet	16°

SELECTING THE *RIGHT* FIELD HOUSING IS *IMPORTANT...*



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CHARTS FOR CALCULATING COOLING TOWER REQUIREMENTS

The three charts and examples included in this table are for the purpose of showing how the approximate size of a cooling tower may be designed.

Conditions: To cool 1500 gal. per min. from 90° to 75° F. with a 3 mile per hour wind and a 70° wet bulb.

Problem 1. Under these conditions how many 6 ft. sections of a 35 ft. high × 12 ft. wide, 12 deck tower are required to accomplish the cooling.

Solution:

T_1 = (inlet temperature) = 90° F.

T_2 = (final temperature) = 75° F.

T_w = (approach to wet bulb) = 75 − 70 = 5°.

C = concentration per sq. ft. of horizontal deck area obtained from Fig. 1.

A = area of one standard tower section, 12 ft. wide and 6 ft. long = 72 sq. ft.

N = number of 12 ft. wide. 6 ft. long tower sections.

To determine the number of sections under the above conditions, the following equation is used:

$$\frac{\text{Gal. per min.}}{C \times A} = N$$

From Fig. 1, C for 35 ft. high tower, for a T_w of 50° and a $T_1 - T_2$ of 15° = 1.17. Substituting in the above equation:

$$\frac{1500}{1.17 \times 72} = 17.8$$

Therefore, under the conditions an 18 section tower 35 ft. high is required.

Problem 2. If the wet bulb is other than 70° upon which Problem 1 is based a wet bulb correction factor must be used. This factor is C_w, obtained from the wet bulb curve Fig. 2. The problem then becomes one of figuring the number of sections required with the same tower height.

Conditions: Wet bulb 65°, 5° approach, 15° temperature drop or $T_1 - T_2$.

Solution: To determine the number of sections under these conditions, the following equation is used:

$$\frac{\text{Gal. per min.}}{C \times C_w \times A} = N$$

C from Fig. 1 for a 35 ft. high tower, a T_w of 5°, and a $T_1 - T_2$ of 15° = 1.17.

C_w (correction factor for wet bulb) is obtained from Fig. 2 and = 0.85. Then substituting in the above equation:

$$\frac{1500}{1.17 \times 0.86 \times 72} = 20.8$$

Therefore under these conditions a 21 section tower 35 ft. high is required.

Problem 3. Assuming that a 35 ft. high tower does not meet cooling requirements due to plant conditions, then a tower of greater or lesser height must be figured. It is then necessary to apply a height correction factor. This factor, C_h is obtained from the height curve Fig. 3. If a tower 51 ft. high, instead of 35 ft. high, is necessary for conditions stated, the following equation is used:

$$\frac{\text{Gal. per min.}}{C \times C_h \times A} = N$$

C_h, correction factor for height, is obtained from Fig. 3 and = 1.63.

Then substituting in the above equation:

$$\frac{1500}{1.17 \times 1.63 \times 72} = 10.9$$

Therefore, under these conditions an 11 section tower 51 ft. high would be required.

In Problem 3, if the wet bulb is other than 70°, C_w, the wet bulb correction factor becomes a part of the equation:

$$\frac{\text{Gal. per min.}}{C \times C_w \times C_h \times A} = N$$

Note: Engineering data and the above examples are approximate only and the sizes of the towers determined should not be regarded as recommendations.

Charts and data supplied by The Fluor Corporation, Ltd.

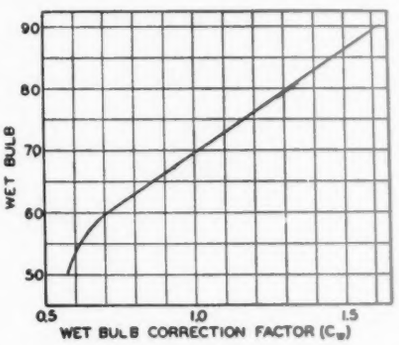


Fig. 2. Wet bulb performance factor

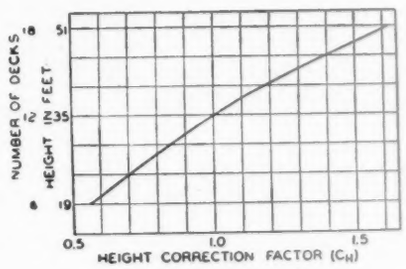
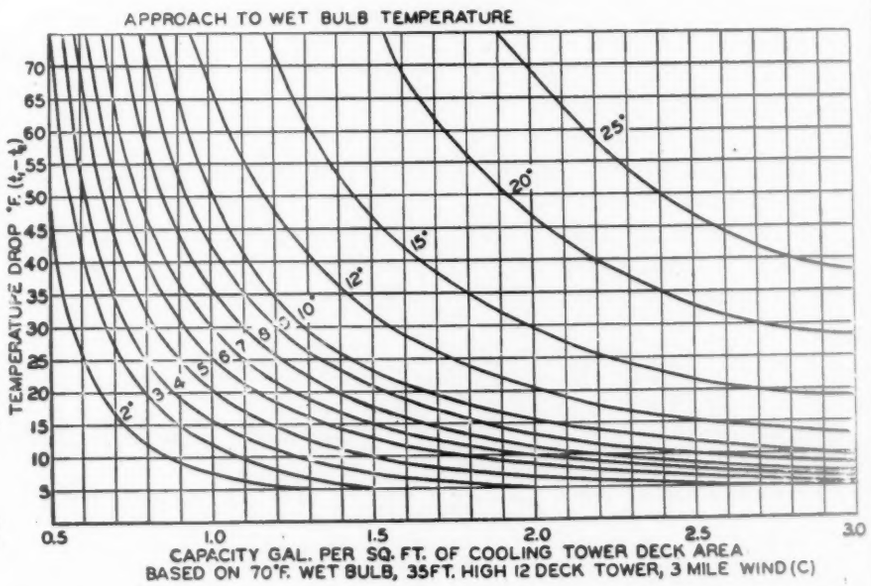
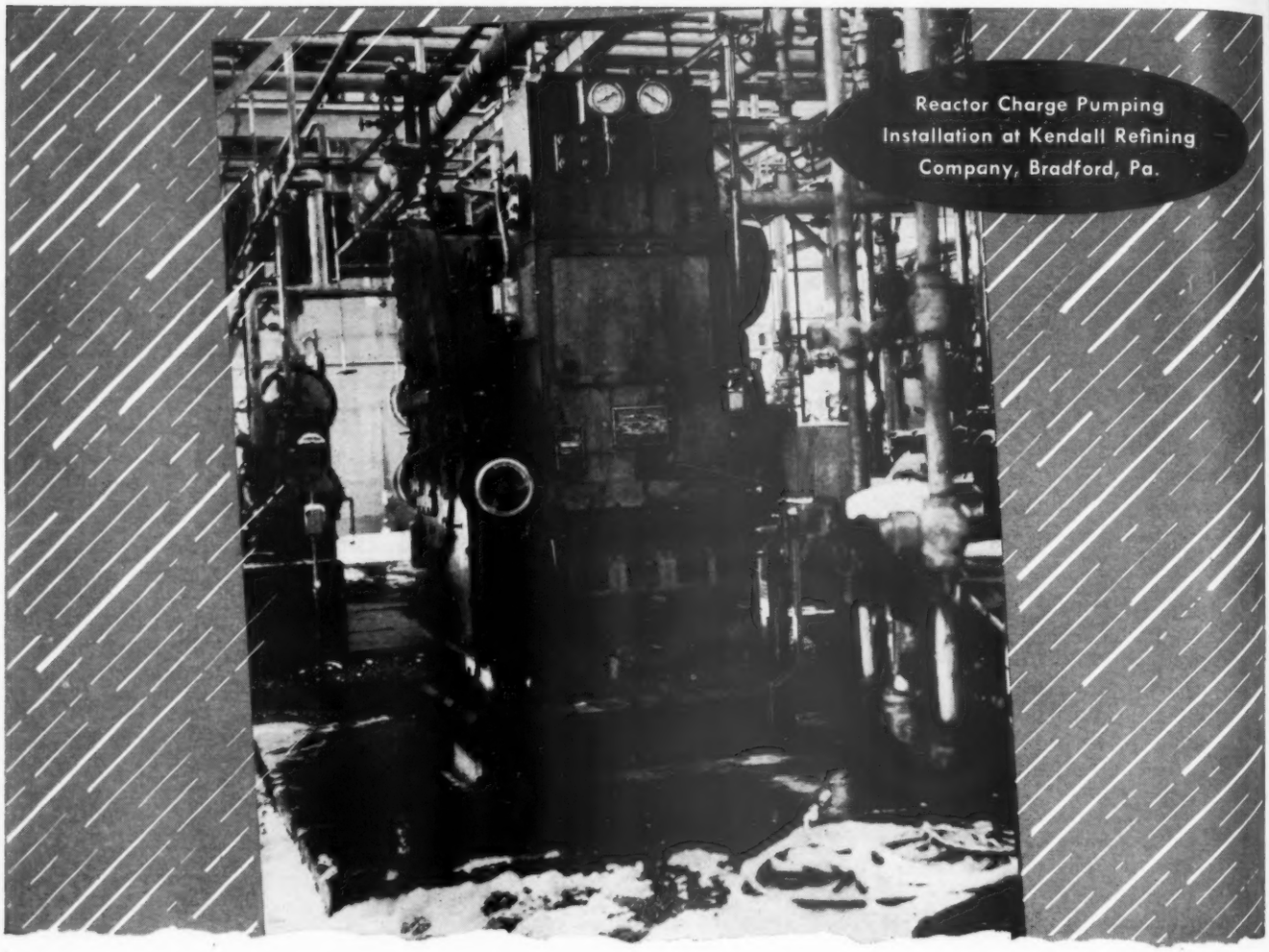


Fig. 3. Tower height performance factor

Fig. 1. Capacity curves





ALDRICH-GROFF VARIABLE-STROKE TRIPLEX PUMP *charges 250 F. depentanizer bottoms into reactors of U.O.P. Platformer Unit*

Severe weather conditions do not affect the performance of the Aldrich-Groff Controllable Capacity "Powr-Savr" Pump, specially designed for economical outside installations. Unit illustrated has a capacity of 0 to 2,472-B/D and has been in operation for 21 months.

The Aldrich-Groff Pump automatically controls charging rate in stepless straight-line fashion without change of driver speed. Power consumption is in almost direct proportion to delivery rate. This pump features compact vertical design, with self-contained reduction gear drive for adaption to high speed motor or turbine, mounted high on the pump frame and safe from normal flood conditions. It affords high pumping efficiency with minimum power cost and negligible maintenance expense. It is a "must" where close process control and service reliability are important factors.

Over 500 Aldrich-Groff Pumps, many with service records of over twelve years, are successfully serving varied industries today. Units are built in 0-2″ through 0-6″ stroke sizes, ranging from 5 to 125 H.P. Contact your nearest Aldrich representative for information—or write us direct for Data Sheet 65A.

THE ALDRICH PUMP COMPANY

26 PINE STREET • ALLENTOWN, PENNSYLVANIA

...Originators of the Direct Flow Pump

Representatives: P. H. Arden, P. O. Box 185, Glenview, Ill. • Bushnell Controls & Equipment Co., 3929 W. Jefferson Blvd., Los Angeles 16, Calif. • L. T. Gibbs, 509 Petroleum Bldg., Tulsa 3, Okla. • R. B. Moore Supply Co., Inc., Bolivar, N. Y. • Power Specialty Co., 2000 Kipling St., Houston 6, Texas • Reeves & Skinner Machinery Co., 2211 Olive St., St. Louis 3, Mo. Stearns-Roger Manufacturing Co., 1720 California St., Denver 2, Colo. • Export Sales: Petroleum Machinery Corp., 30 Rockefeller Plaza, New York 20, N. Y. • Birmingham • Boston Buffalo • Cincinnati • Cleveland • Detroit • Duluth • Jacksonville • Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. • San Francisco • Seattle • Spokane, Wash. • Syracuse

CHARTS FOR CALCULATING COOLING TOWER REQUIREMENTS

The size of a cooling tower required to handle a given heat load varies greatly with the performance required, and care should be used in specifying the wet bulb temperature, the final approach of the tower water to the wet bulb temperature, the wind velocity, and the quantity and temperature range of the tower water being circulated.

If plant operation requires the maintenance of a definite minimum temperature it is essential that the highest prevailing wet bulb temperature, usually occurring during July, August and the early part of September, be used in rating the tower. Then, when the wet bulb temperature drops and colder tower water is obtained, the quantity of cooling water being circulated may be decreased.

Approach of the final tower water to the wet bulb temperature should be made as large as possible to avoid unnecessarily increasing the tower size. Fig. 1 illustrates the above point by showing the relation between tower size and approach to the wet bulb temperature while circulating a constant quantity of water through a given temperature range. In specifying the operating conditions an approach of not less than five degrees and preferably ten degrees or greater is recommended.

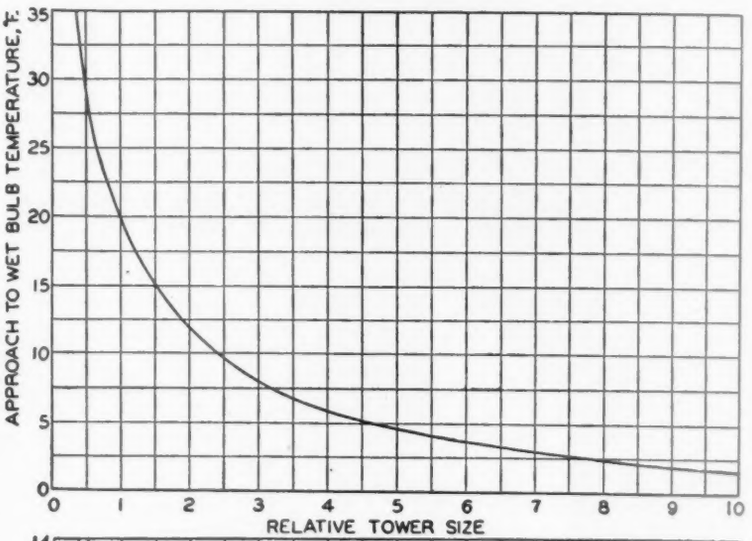
The relative size of a tower varies with the wind velocity as shown in Fig. 2. In order to obtain the required minimum temperature during the summer months, care should be taken to specify a wind velocity which is representative of the poorest conditions experienced during the warmer months rather than a figure which represents the average wind velocity over a period of years.

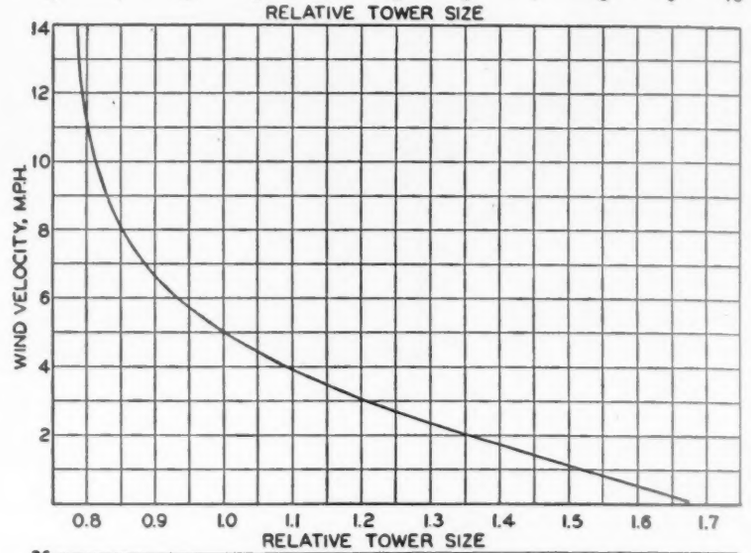
Selection of the proper circulation and temperature range of the tower water is often more or less definitely determined by process requirements. Since tower prices are proportional to their respective sizes the smallest tower capable of handling the heat load is the most economical one to use.

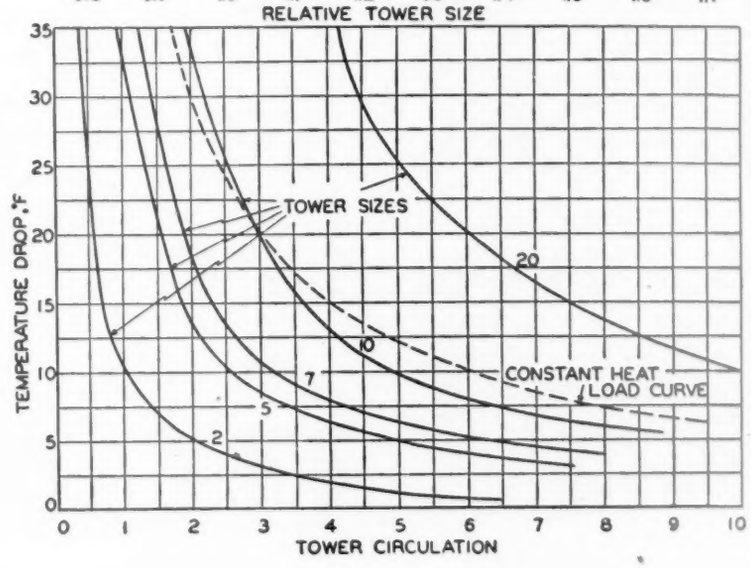
Fig. 3 further illustrates the relation between capacity, range and tower size. In general, because of the larger cooling potential, it may be concluded that for the same heat load, less tower is required for cooling a small quantity of water through a large temperature range than is required for cooling a large quantity of water through a small temperature range.

Note: Engineering data and the examples below are approximate only and the sizes of the towers determined should not be regarded as recommendations.

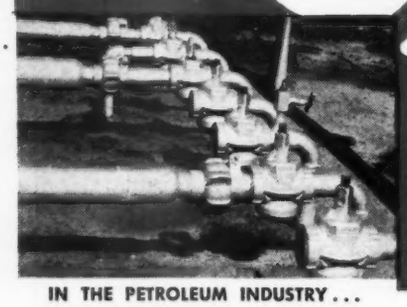
—Charts and data supplied by The Fluor Corporation, Ltd.





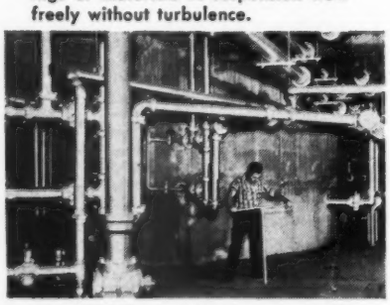


WHAT DOES FULL PIPE AREA MEAN TO YOU?



IN THE PETROLEUM INDUSTRY . . . a.c.f. Cylindrical Plug Valves give full flow, quick quarter-turn shut-off.

ON CHEMICALS viscous heavy ladings or materials in suspension flow freely without turbulence.



IN SEWAGE PLANTS a.c.f. Cylindrical Plug Valves handle raw sewage with ease—plug shears obstructions.

It means, primarily, a smooth, straight-through flow. Look through an a.c.f. CYLINDRICAL Plug Valve, and you'll see why solids in suspension and heavy, viscous ladings pass so easily. There are no restrictions to retard flow! The valve port has an area at least as large as the pipe itself. For the lowest head loss of *any* plug valve in the world, specify a.c.f. CYLINDRICAL, Lubricated Plug Valves. You'll save time and pumping cost!

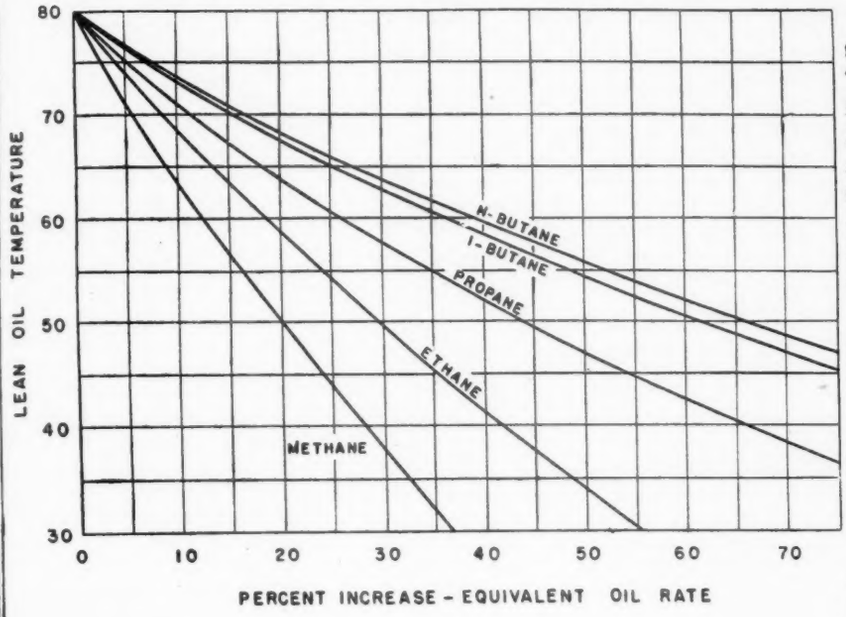
a.c.f. CYLINDRICAL FULL PIPE AREA PLUG VALVES

Write for Catalogue 4-PE, American Car and Foundry Co., Valve Division, 1501 E. Ferry Ave., Detroit 11, Mich.

Representatives in 50 Principal Cities

REFRIGERATION DATA FOR GASOLINE PLANTS

FIG. 1. OIL TEMPERATURES VS. EQUIVALENT OIL RATE.



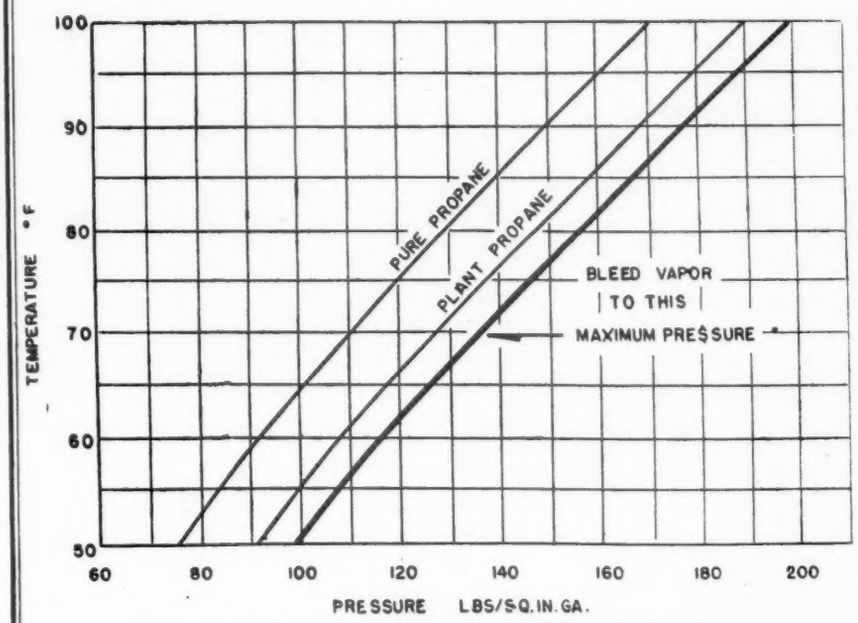


FIG. 2. CONDENSER, PRESSURE-TEMPERATURE CURVES.

These curves and table are taken from the article entitled "Practical Refrigeration for Natural Gasoline Plants," by R. W. Heath, J. B. Taylor, Jr., and P. W. Hill of the Signal Oil and Gas Company that was published in the May 1946 issue of *The Petroleum Engineer*, pages 162 to 176.

Fig. 1 (left) shows the relationship between lean oil temperatures below 80°F. and the increase in absorption of the oil as the temperature is reduced by refrigeration.

For example:

Lowering the temperature from 80°F. to 55°F. is equivalent to increasing the oil rate 50 per cent insofar as the butanes are concerned, 35 per cent for propane, 24 per cent for ethane, and 17 per cent for methane.

Fig. 2.—This is a curve based on the actual analysis data in Table 1 and shows that the refrigeration capacity is best when small quantities of vapor are removed by bleeding to a limited discharge pressure.

TABLE 1—Propane analysis.

	A	B	K	D	E	F
Analysis, mol per cent						
Carbon dioxide	2.10	0.30	7.00	0.00	0.15	0.10
Methane	7.35	0.51	14.41	0.00	0.19	Trace
Ethane	7.69	2.88	2.67	0.04	2.33	1.23
Propane	82.70	95.95	0.86	98.54	96.95	98.36
Isobutane	0.16	0.36	0.44	1.03	0.38	0.27
Normal butane	0.00	0.00		0.39	0.00	Trace
Total	100.00	100.00		100.00	100.00	100.00
Specific gravity	1.421	1.531		1.551		

Explanation of Table 1:

A—Condenser accumulator vapor, 172 lb. per sq. in. abs. and 79 °F.
B—Condenser accumulator liquid 17. lb per sq. in. abs. and 79 °F.
Plant propane before any bleeding—vapors to compressor.
K—Equilibrium constants, A/B
D—Liquid in chiller—lube oil removed.
E—Condenser accumulator liquid, 162 lb per sq. in. abs. and 79 °F
Plant propane after bleeding approximately 10 per cent off B
F—Plant propane from Signal Hill plant.
Specific gravity taken by Edwards Balance
A to D samples procured at Huntington Beach before bleeding and E after bleeding

LAUGH with BARNEY

"Here I've been roasting over a hot stove," cried Bridget to Mike upon his return from work, "while you've been passing the day in a nice cool sewer."

A man travelling through a small town stopped at a general store. Hearing a clucking hen in the back he asked what she was doing there.

"That's the craziest hen you ever saw," the proprietor told him. "She sat on a doorknob for three weeks, and just recently an old mother cat that stays around here got run over and she adopted the three kittens."

Doubtfully the man looked under the hen and sure enough there were three little kittens. Noticing a small boy in the front of the store he motioned to him: "Come here, son, I want to show you something. What do you think of that."

Staring at the kittens incredulously, the boy asserted, "I think I've et my last egg!"

Flying over the Rocky Mountains, an airline hostess passed out chewing gum to the passengers.

"It's to keep your ears from popping at high altitude," she explained.

When the plane landed, one of the passengers rushed up to the hostess and said: "I'm meeting my wife right away. How do I get the gum out of my ears?"

The Club bore was boasting of his ability to distinguish between different beverages. Finally one of the listeners took a flask from his pocket and asked the connoisseur to taste and tell him what it was. The man tasted a mouthful and promptly spat it out. "Great Scott!' he cried, "Thats' gasoline."

"I know," came the bland reply, "But what brand?"

A big business magnate was visited by a boyhood chum whom he had not seen for years. This man told him a long story of misfortune; bankruptcy, death of wife and children, long personal illness, and more — and ended with a plea for help. The big shot pushed a button on his desk, and a burly porter appeared. "Sam," he instructed in a sob-choked voice, "throw this poor fellow downstairs — he's breaking my heart."

A young Missouri soldier who had never seen the ocean was placed as a sentinel on the Virginia shore and told to hold his ground. Some hours later, when the tide was in, the captain came looking for his guard, and found him up to his neck in water.

Captain: Why, you fool, what are you doing there?

Soldier: Captain, I'm holding the ground, but this creek's riz.

"It's oil, Captain--LANE-WELLS on the job"

"Oh, here's the place mother told me to stay away from. I thought we'd never find it."

In a Southern court a lawyer was cross-examining a witness from a plantation, and was getting along fairly well until he asked the witness what his occupation was. "I'se a carpenter, suh," was the reply.

"What kind of carpenter?" asked the lawyer.

"Dey calls me a jackleg carpenter."

"What is a jackleg carpenter?"

"Hes' one whut ain't a fust-class carpenter, suh."

"Well, go on. Explain fully what a jackleg carpenter is."

"Bos, ah declare, ah dunno how to 'splain any mo' 'cept to say hit am jus' de difference 'twixt you and a fust-class lawyer!"

This story concerns the case of a man who was bothered by bedbugs in his berth on a train and who wrote a hot letter about the matter to the passenger agent of the railroad.

His friends told him that he would probably not even receive the courtesy of a reply and so his satisfaction was great when he shortly received an extremely polite and apologetic letter assuring him that such a thing would never happen again. His elation was short-lived, however, when a second later, out of the envelope, fell an interoffice memo inadvertently inserted, which read, "Send this dope the Bug letter."

The president of a southern bank was berating his porter for coming to work later and later each day.

"Don't you want to amount to something?" he asked. "Don't you know that you will never get anywhere unless you get up early in the morning?"

"Well, Ah don't know," replied the porter. "Ah've noticed that them that gets up early goes to them that gets up late to get paid."

The wife of an oil company executive called on the wife of an underling making only $50,000 a year. "How chic," she cried, "a black telephone!"

A wealthy man from a large Eastern city bought a farm in a mountainous section of the South and he was looking for a married couple to run it for him while he was away on business. An elderly couple applied for the job and he was interviewing the woman.

"How long have you been married?" he asked.

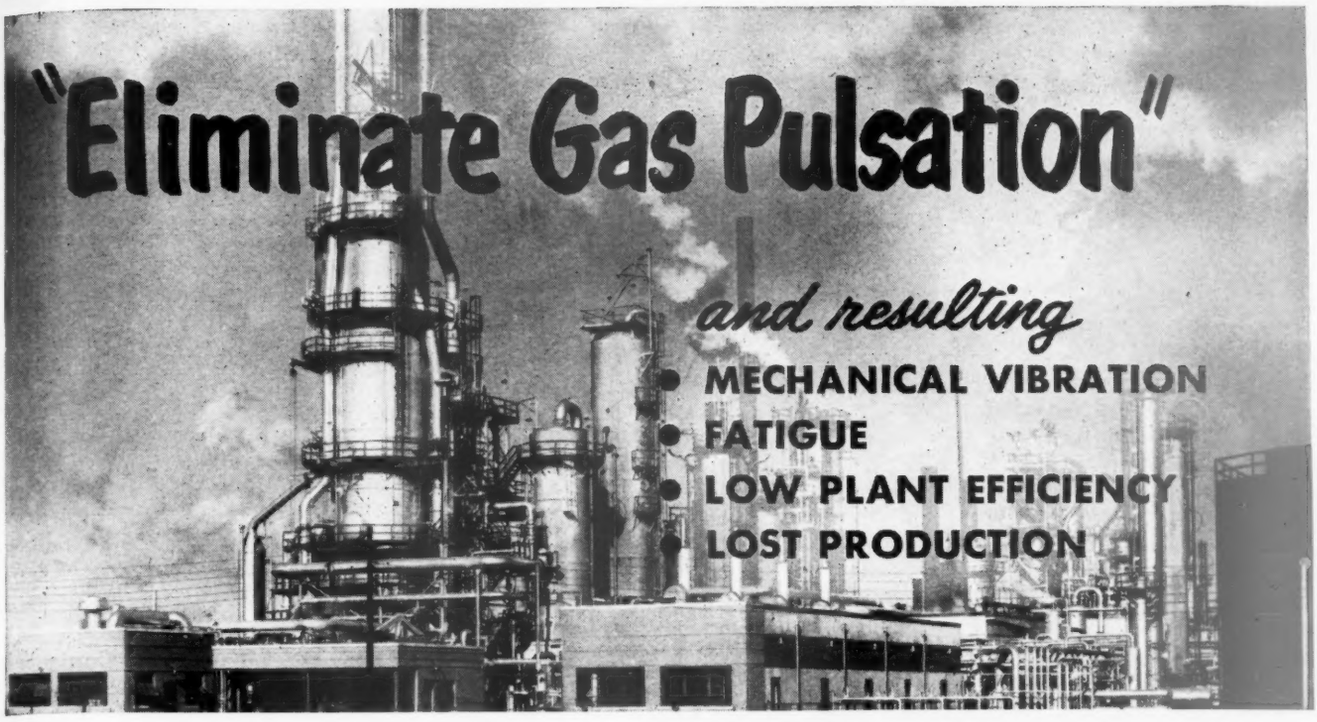
"Thirty-five years," was the reply.

"And what is your name?" asked the new owner.

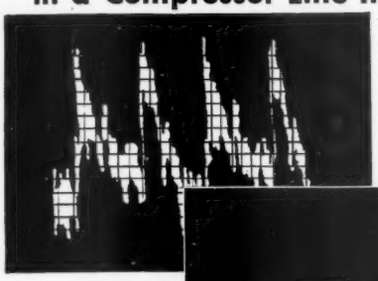
"Anna," said the woman.

"And what is your husband's name?" she was asked.

The woman thought for a long moment. Then she turned to her husband who was standing near her and said: "Pa, what is your name?"

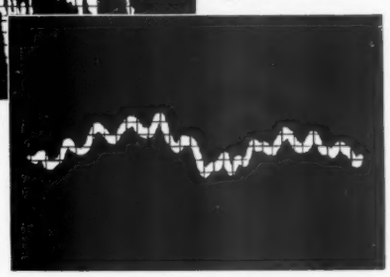


Solution to a typical Surge Problem in a Compressor Line Installation



BEFORE

Second stage discharge before Snubber installation: Maximum peak pressure change 45 lb; nominal line pressure 450 lb.



AFTER

Second stage discharge after Snubber installation and downstream of Snubber: Maximum peak pressure change 4 lb; line pressure 480 lb.

Send for your copy of a typical Burgess-Manning Pulsation Survey and Analysis Report

BURGESS-MANNING PULSATION SURVEY

Burgess-Manning pulsation surveys are conducted by trained and fully experienced engineers with electronic equipment including pressure pickup (transducer), amplifier, and oscilloscope. The pressure transducer is coupled as close to the gas stream as possible and faithfully reproduces in voltage the pressure changes in the pipe. This voltage is conducted to a three stage amplifier and then to the oscilloscope screen. Photographs are taken of the screen as a record of surge. Data is taken and recorded. Maximum peak pressure change is calculated. Report is prepared. Recommendations are made that best solve your problems.

CONSULT BURGESS-MANNING ENGINEERS

Gas pulsation in compressor piping systems often results in excessive vibration and material fatigue. This, in turn, necessitates constant maintenance in piping and equipment resulting in lower over-all plant efficiency.

Your compressor system pulsation problem can be solved by Burgess-Manning Company engineers. This division maintains a field service to make surveys and analyses of flow conditions in pressure piping. Trained engineers correlate this data for reference in making Burgess-Manning Gas and Air Line Snubber recommendations for new plants as well as for existing plants.

Write for your copy of a typical case history in which Burgess-Manning engineers solved a tough problem.

Typical application showing Burgess-Manning Gas and Air Line Snubbers installed on discharge side of multiple-stage gas compressors.

Burgess-Manning Gas & Air Line Snubber.

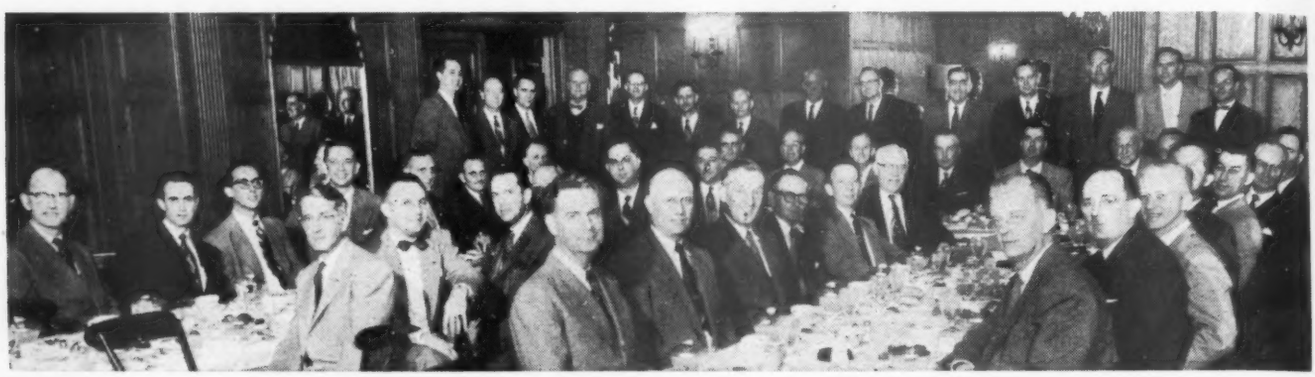
BURGESS-MANNING COMPANY

1203 Dragon Street
DALLAS, TEXAS

Chicago, Illinois — **Libertyville, Illinois**

REPRESENTATIVES: Houston • Tulsa • Los Angeles • St. Louis • New York

OIL and GAS TRADE NEWS



Lane-Wells Company executives met recently in Los Angeles with supervisory personnel from the head office and manufacturing departments. Division managers from Houston, Texas, Oklahoma City, and Paramount, California, attended the meeting.

Worthington Division Sets New Record in 1952

Worthington Corporation's air conditioning and refrigeration division's product sales for 1952 were 20 per cent above 1951, it was revealed recently by M. M. Lawler, assistant vice president and manager of the division. Lawler reported that the combination of removal of curbs on commercial construction early in the year, along with a nationwide hot spell, plus a high level of industrial expansion made 1952 a record year.

U. S. Agents Named

Manufacturers of the Lovibond Tintometers and Comparators, of Salisbury, England, announce the selection of Curry and Paxton, Inc., as the United States distributor for their entire line of equipment. Curry and Paxton, Inc., have established showrooms, warehouses (including bonded warehouses for re-export to South America, the Pacific, etc.) and factory-trained personnel to supply and service their world-renowned line of color measuring equipment.

In preference to the old casual method of distribution through dealers via importers, the company has set up its organization scientifically for the purpose of providing expert skilled technical assistance to dealers and customers.

Weld X-Ray Expansion

Opening of regional offices in Houston, Denver, Chicago, Los Angeles, and Woodbridge, New Jersey, has been announced by H. K. Hovland, president, Industrial X-Ray Engineers, Seattle.

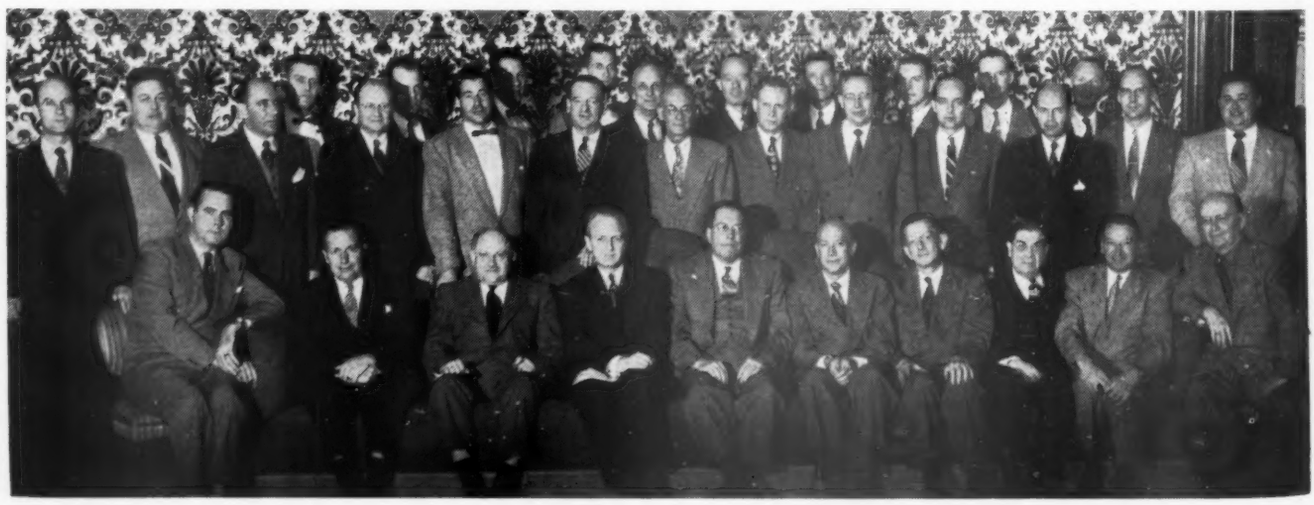
Regional managers of the new offices are: Boyd Collier, Houston; William R. "Bill" Smith, Denver; Charles Tewell, Chicago; W. J. "Bill" Parker, Los Angeles; Ray D. Flatland, Woodbridge. R. R. Hughes, vice president in charge of operations, will transfer from Tulsa to Seattle, Washington. John Watt will be manager of the Tulsa office.

Three New Distributors Named by Koehring Company

Appointment of new distributors for territories in Wisconsin, California, and Florida has been announced by Koehring Company. In Wisconsin, Kelbe Brothers Equipment, Milwaukee, will handle Koehring products for the entire territory. In Florida Koehring has named Allied Equipment, Inc., Miami, to handle Koehring products only in the 13 southern counties of the state. The Northern California territory has been delegated to the Standard Machinery Company, San Francisco.

Riley Firm Reactivated

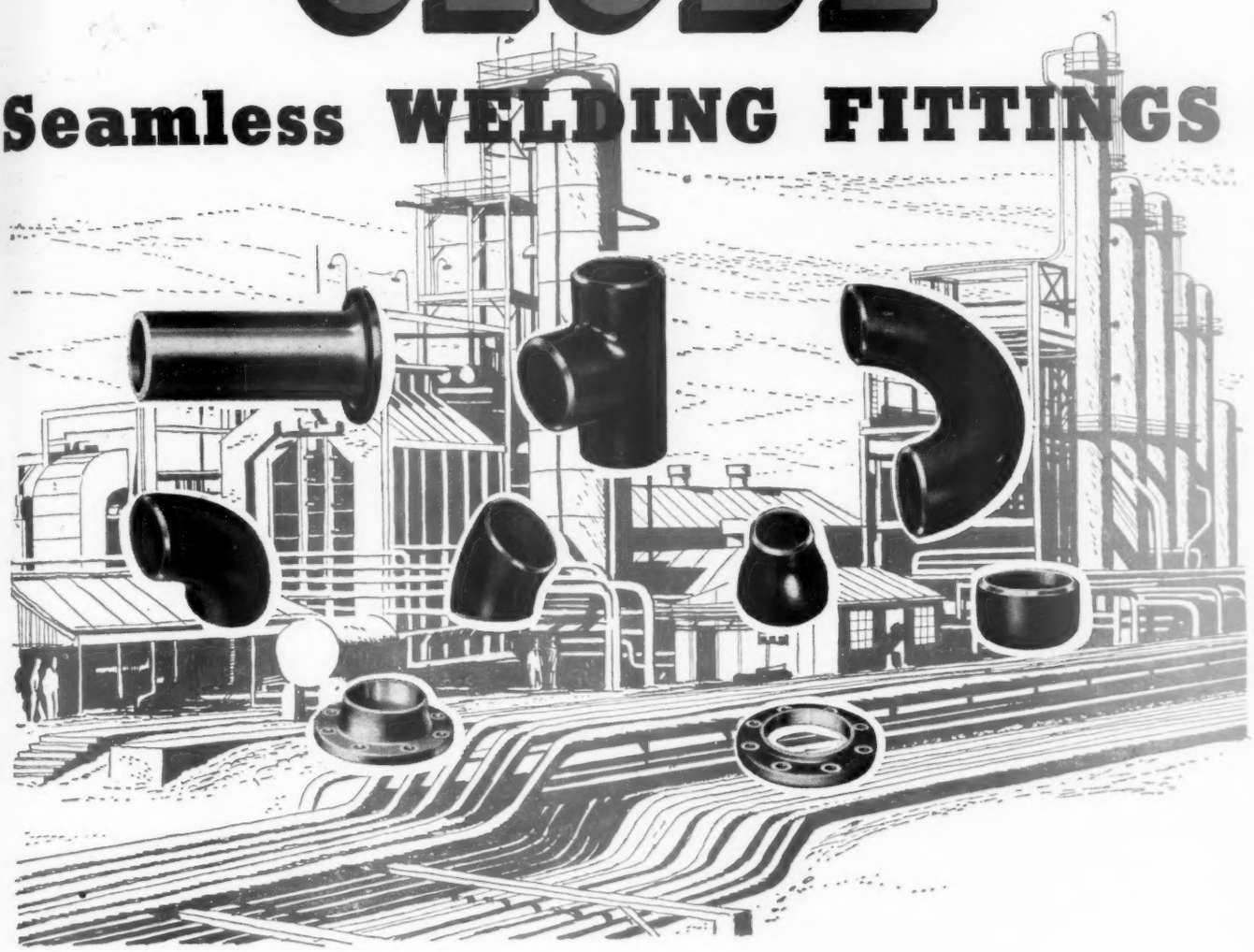
John C. Riley has reactivated his original firm, J. C. Riley Company, Houston, Texas. He will serve as factory representative in the Southwest for C. M. Kemp Manufacturing Company, Reading Crane and Hoist Corporation, International Engineering, Inc., and Midwest Alloys, Inc.



Enterprise Engine and Machinery Company salesmen and home office personnel held their annual diesel engine sales meeting in San Francisco recently. Attending were: Seated, J. L. Adams, G. C. Rasey, J. H. Sheusner, P. I. Birchard, W. E. Butts, J. Wendell Coombs, W. E. Clayton, Jr., G. B. Wright, R. E. Kroeck, G. J. Brusher. Second row, M. T. Prendergast, Wren Malone, P. K. Wabnig, H. L. Hansen, J. C. Roberts, J. Neil Brophy, T. S. Pennebaker, W. E. Bishop, H. T. Anderson, Paul Sullivan, William F. Haddon, Bruce Robbins, Dale Blanton. Back row, J. E. Barthmaier, Ken Cramer, H. D. Bahr, R. L. Rahn, W. H. M. Porter, T. S. White, J. F. Yeldell, C. R. Carmichael, George Cashman, H. R. Hogaboom. All were enthusiastic about prospects for the coming year.

GLOBE

Seamless WELDING FITTINGS



The only seamless welding fittings precision-processed . . . from billet . . . to tube . . . to fitting

From charging the specially designed revolving furnace with a steel billet (above) through the many succeeding steps of production, every Globe process is specialized to produce fittings of unvarying quality.

Globe precision-process manufacture begins with the billet —continues through the making of the seamless steel tube (Globe alone among welding fittings manufacturers produces seamless steel tubes)—and extends through to the production of the finished fittings.

Because Globe has highly specialized controls—at every stage of manufacture at its own plant—you can be sure of uniform high quality seamless welding fittings when you specify Globe.

Send for the Globe Welding Fittings complete catalog.

GLOBE STEEL TUBES CO.,
Milwaukee 46, Wisconsin

Chicago • Cleveland • Detroit • New York • Philadelphia • St. Louis • Denver • Houston • San Francisco
Glendale, Cal.

Producers of Globe Welding Fittings — Globe seamless stainless steel tubes — alloy-carbon seamless steel tubes — Gloweld welded stainless steel tubes — Globeiron (high purity ingot iron) seamless tubes.

AVAILABLE IN A COMPLETE LINE OF SIZES AND WEIGHTS THROUGH GLOBE DISTRIBUTORS IN ALL KEY CITIES

Scenes from Continental Supply's 13th annual meeting include: W. J. Morris, chairman of the board, E. F. Schaefer, president, Gardner-Denver; F. M. Mayer, president, Continental; J. A. Mussler, general manager of sales, and H. H. Peters, vice president, Continental, and O. W. Barnett, manager district sales, Rockwell Manufacturing. Meeting was held in Dallas on March 3.

Continental Supply Meet

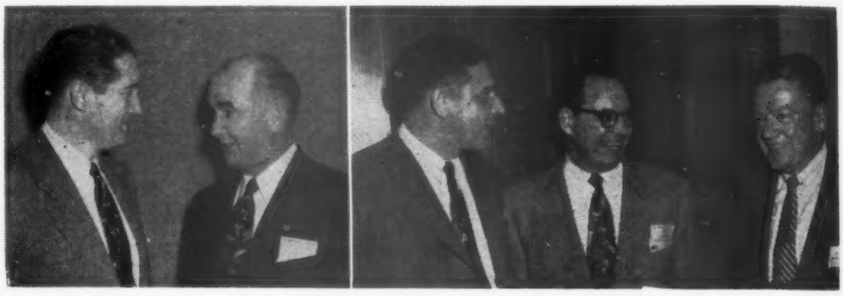
Amid such comments as "the most successful meeting we've ever had," some 200 representatives of The Continental Supply Company completed their 13th annual sales meeting in Dallas March 3. Attending the three day meeting were 76 representatives of Continental's Associated Manufacturers.

The entire group visited Emsco D & B plant in Garland where they watched the steps in the manufacture of surface and sub-surface production equipment. They also saw a demonstration of the new "vest-pocket" Emsco GB-160-T rig; a Gardner-Denver FK-FXK pump; and an Emsco unit pumper complete with a CSCO pumping engine equipped with the new CSCO mechanical engine starter and automatic gas-gasoline carburetor. One day was spent attending sessions conducted by associated manufacturers.

W. J. Morris, Continental's board chairman who has over 40 years of service with the supply company and its parent company, Youngstown Sheet and Tube, was elected 1953 president of the 25-Year Club at their annual meeting. On the less serious side, C. N. Swanson, Continental's director of purchases, won himself the title of "1953 Gin-Rummy Champ" in the yearly tournament.

Both F. M. Mayer, president, and F. I. Brinegar, executive vice president, expressed pleasure with the results of the meeting during the closing session.

Manufacturers represented were: Broderick and Bascom Rope; Chain Belt; Clayton Mark and Company; Climax Engine and Pump Manufacturing; Emsco Manufacturing Company; Gardner-Denver; Ladish Company; Lunkenheimer; New York Belting and Packing; Rockwell Manufacturing; Technical Oil Tool Corporation; and Youngstown Sheet and Tube.



J. A. Conlon, vice president, New York Belting and Packing chats with F. I. Brinegar, executive vice president, Continental Supply, at Continental's annual meeting. At right is W. O. Kupper, Ladish, J. A. Davis, Continental, and Roy R. Bush, Rockwell.

Baash-Ross Tool employees from the Northern Mid-Continent area met in Oklahoma City recently for regional sales conference. Attending were: Front row, R. L. Bowcutt, Casper; M. T. Jimerson and R. L. LeBus, Jr., Oklahoma City; F. L. Tooley, executive vice president, Los Angeles; H. C. Siegley, Wichita Falls, and L. L. Downing of Wichita, Kansas. Back row, B. G. Prichard, Duncan; P. R. Nagle, Oklahoma City; K. S. Ross, export manager, New York City; W. P. Pound, Oklahoma City; W. H. Wallace, Great Bend, Kansas; H. Wotkyns, vice president in charge of Northern Mid-Continent operations, Oklahoma City, and H. R. Martin, Casper. (Pictured below) California division of Baash-Ross also met recently. Attending were: Hal Messinger, John Dickman, E. G. Streight, Tom Boyd, F. O. Knoblock, G. R. Brown, E. W. Carne, H. L. Richards, W. Y. Cadwallader, F. L. Tooley, A. A. Hilliard, Roy Johnson, Republic Supply; L. J. Laird, and E. M. Gearke.

Lang to Handle Chiksan Sales in Utah, Idaho

The Lang Company has been appointed exclusive industrial sales representative for Chiksan Company in Utah and Idaho. Sale of Chiksan ball-bearing swivel joints and assemblies, loading racks, Weco unions, and other products will be handled by the oil equipment division of the Lang Company.

Peerless Pump division, Food Machinery and Chemical Corporation sales personnel met for a 5-day meeting in Indianapolis, Indiana, recently. Demonstrations of Peerless' principal products were a feature of the meeting. B. A. Tucker, Peerless sales manager, was chairman.

Midland Office Opened

Cardinal Chemical, Inc., announces opening of new combined sales-and-engineering office, Room 104, V&J Tower, Midland, Texas. Midland office services cover all Cardinal products. J. W. Sallee, Ken Ward, and Al Dillard will make Midland their headquarters. Other Cardinal offices are at Odessa and Levelland, Texas, and Hobbs, New Mexico.

J. W. Sallee

Carter Agents Named

S. C. Carter Company, Inc., announce the appointment of Wilson and Johnstone Ltd., as distributors for Trinidad and Tobago, B. W. I. Wilson and Johnstone Ltd., will handle sales and service of the Carter units from their headquarters at Port of Spain.

Liquid Oxygen Plant Open

The recently completed Air Reduction Sales Company liquid oxygen plant in Butler, Pennsylvania, has commenced delivery of oxygen to industrial customers. The plant, which represents a capital outlay of "several million dollars" supplies oxygen directly by pipe line to two Butler customers, Armco Steel Corporation and Pullman Standard Company. In both cases these companies use oxygen in the processing of steel. The gases produced at Butler will be sold throughout the Midwest.

California Offices Set Up

The Hammel-Dahl Company of Providence, Rhode Island, announces the opening of two California offices. Both offices will be devoted to sales and service of Hammel-Dahl products and will be under the supervision of Thomas H. Ponton. A graduate of the University of Rhode Island, Ponton has had previous experience in the West Coast area while associated with the E. I. du Pont.

Employee Department Set Up

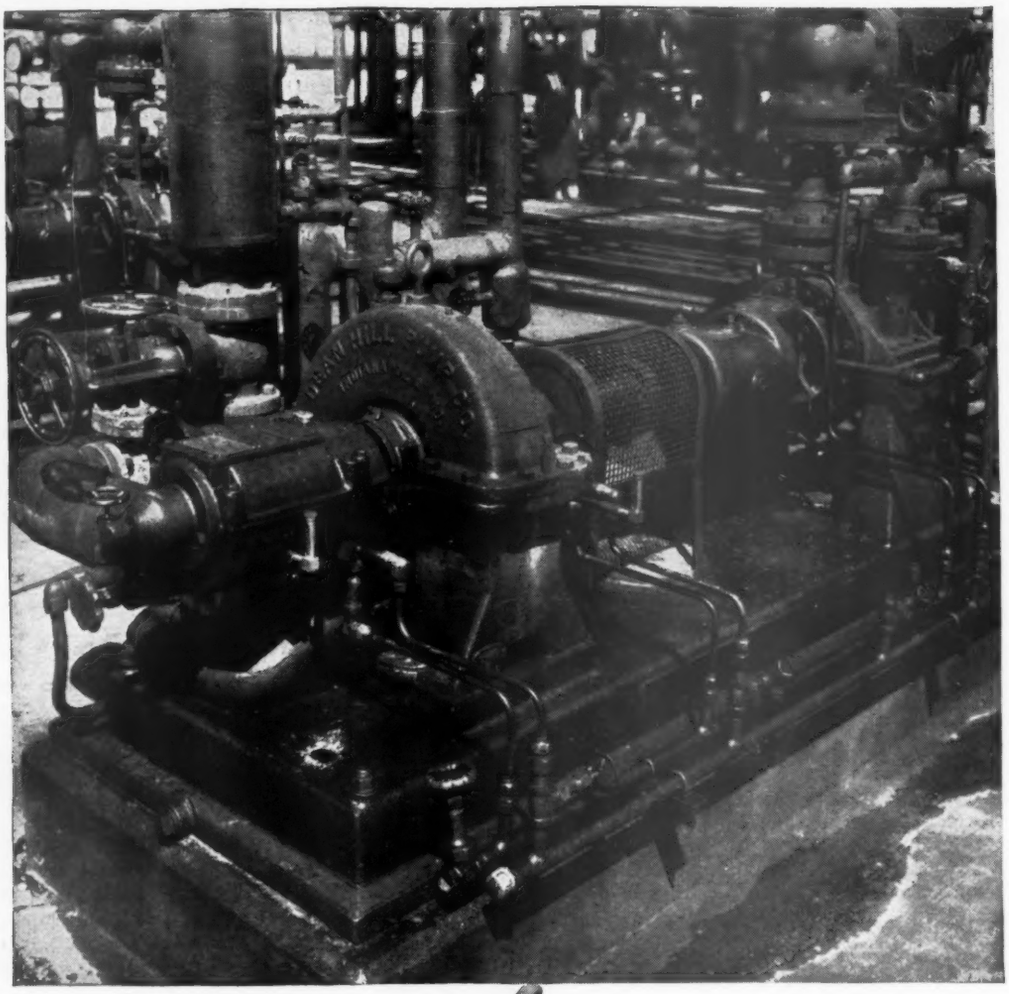
Core Laboratories, Inc., has announced the establishment of a complete employee relations department to coordinate and direct the personnel activities of its 27-district and field offices. Recently employed as manager of the new department is Gould Whaley, Jr., formerly associated with Atlantic Refining. Whaley joined Atlantic in 1946.

Gould Whaley, Jr.

Carlson Heads New Branch

The A. O. Smith Corporation announces the opening at Oakland, California, of a new service branch of its product service division. The new branch is designed to provide a central West Coast location. George A. Carlson is manager of the new Oakland branch.

Sales plans for the coming year were outlined at the Rust-Oleum sales meeting in Evanston, Illinois, recently. Attending were: First row, A. A. Ahlff, Robt. K. Phipps, Jack Holt, J. E. Merritt, Otis B. Casanova, John Winter, J. Olin Jones, Sr., H. W. Edwards, Ted White, Warren A. Risk, U. S. Ackles. Second row, W. D. Home, Thos. F. O'Malley, John A. Larson, Walter Fenn, R. R. Stabley, Donald W. Fergusson, vice president, Arnold Hoffmeyer, manager, sales research and promotion department, J. R. Boren, Lee Hill, Earl Lyons, J. H. Moran. Third row, Dale W. Kimmel, P. H. Webb, L. J. Rumig, R. J. Zobel, J. R. Baker, W. A. Bellows, T. R. Mumford, Thos. S. Walsh, J. H. Lund, Robert Gray, (advertising agency). Fourth row, H. P. Barth, Erwin G. Randt, Paul Moffit, R. D. Repass, J. C. Simmons, Arthur Cowan, Wm. O'Grady (advertising agency), Robert Hoffmeyer (superintendent Rust-Oleum manufacturing plant), N. J. Noah, Jack Copeland. Standing, Robert A. Fergusson, preaident. Sales prospects for 1953 were very bright, it was reported.

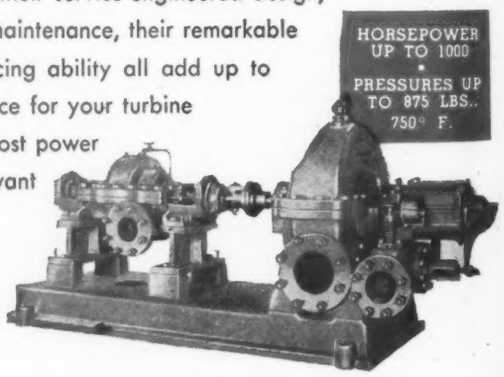


DEAN HILL STEAM TURBINES

are single stage, double impact type for low steam consumption. Specifically designed for operation at medium steam pressures and temperatures, DH Turbines have all the advantages available under these conditions, including excellent water rates. Get the full details and complete specifications. Write today.

POWERFUL "PENNY PINCHER"

Power a-plenty at a penny-pinching cost! That's how DEAN HILL STEAM TURBINES operate. Their super rugged construction, their service-engineered design, their low maintenance, their remarkable power-producing ability all add up to far more service for your turbine dollar. If it's low cost power you want . . . you want DEAN HILL STEAM TURBINES.



DEAN DH HILL PUMP COMPANY

Pump and Turbine Engineers Since 1895

INDIANAPOLIS 7, INDIANA

SALES OFFICES IN:

Chicago • Mexico City • Philadelphia • Salt Lake City • New York • Dallas • New Orleans • San Francisco • Denver • Los Angeles • Pittsburgh • Houston • St. Paul • Cleveland

District salesmen and engineers from the Happy Company met in Tulsa, Oklahoma, recently for their annual sales meeting. Latest improvements in the company's pumping units, engine starters, belting, hose, and heat transfer equipment were explained.

Hughes Plans Expansion Of Houston Plant

A new three-year expansion program that will increase the capacity of Hughes Tool Company's Houston, Texas, plant approximately 40 per cent, was announced by Fred W. Ayers, senior vice president and general manager. Construction of the first of the new buildings in this long-range program will get underway shortly, according to Ayers. Increased capacity of the plant will further boost the company's payroll of 5000.

Philco Operations Merged

James H. Carmine, executive vice president, Philco Corporation, has announced the manufacturing and distribution operations of Philco Corporation of Canada, Ltd., Toronto, have been integrated with Philco International Corporation. Sydney L. Capell is president of Philco International with headquarters in Philadelphia. At the same time Capell announced that W. H. Jeffery, general sales manager of Philco's Canadian corporation has been named general manager of that company. L. B. Kiely, formerly merchandising manager, succeeds Jeffrey as general sales manager.

Instrument Park Planned

Plans for the development of "Instrument Park," an industrial community with a "university campus atmosphere," were revealed by Philip S. Fogg, president of Consolidated Engineering Corporation. The local electronic analytical instruments firm filed an application with the Pasadena Planning Commission requesting a zone change to permit light manufacturing use of a 20-acre site north of the company's existing plant in the Hastings Ranch area.

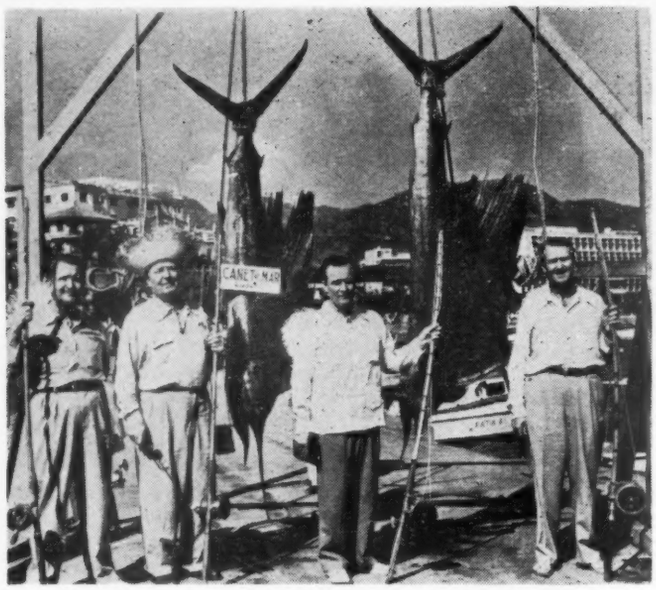
Ansul-Chemical Sets Up Offices in Southwest

Ansul Chemical Company, of Marinette, Wisconsin—pioneer in dry chemical fire extinguishing equipment — is opening new branch offices in the Houston, Dallas-Fort Worth, Texas, and Tulsa, Oklahoma, areas.

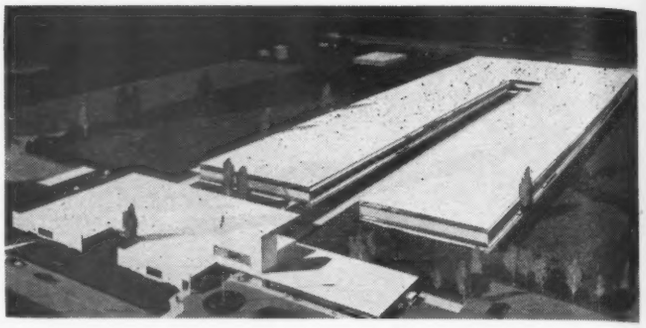
C. H. Armstrong

Visiting these cities in connection with the opening of the offices is Robert C. Hood, 35-year-old Ansul president. Hood expects Ansul to double or treble its volume in Texas and Oklahoma. District sales will be supervised by C. H. Armstrong, who is already well known to the oil industry in Texas.

McEvoy products were discussed in detail at the company's annual three-day sales conference in Houston, Texas. Attending the meeting were: Seated, W. O. Hedrick, A. F. Rhodes, J. C. Rebman, C. F. Johnson, all of Houston. Standing, B. J. Barber, D. D. Jones, J. E. Roberts, J. C. Sikes, Robert Eichenberg, R. H. Washburn, A. C. Oden, H. D. Start, P. L. Harrison, B. E. Ites, J. L. Wallace, R. W. Benson, E. L. Bissett, J. W. Roff, A. J. Felscher, Roy Ooley, John Ingram, I. C. Wells, J. W. Robertson, J. C. Shuptrine, C. P. Lanmon, H. M. Stanley, Ross Holloway, and P. H. Meyers. Not pictured, was George A. Butler, chairman of the board of McEvoy.



Acapulco, Mexico, is rapidly becoming winter headquarters for oil men. Fishermen, with a catch of two beautiful sailfish, are: F. L. LeBus, Sr., president of LeBus International Engineers, Ltd., and North Texas oil producer, Longview, Texas; Ira A. Marshal, oil producer, Los Angeles, California; G. F. LeBus, Jr., and Roy H. LeBus, also oil producers in North Texas.



Drawing of Beckman Instruments' new plant.

Beckman Factory Planned

Arnold O. Beckman, president and founder of Beckman Instruments, Inc., officially broke ground for the new $2,000,000 instrument factory and administrative offices to be erected in California. Ralph McFadden, Orange County supervisor, proffered the official welcome before a group of county and municipal officials, local civic leaders, and Beckman executives.

First occupancy is scheduled for midsummer with completion of the first unit later this year. Although Beckman employees now number about 1500 the site has been chosen to allow a four-fold growth for a possible organization of

J. G. Long

H. A. Helms

Cameron Divisions Set Up

Cameron Iron Works has established two divisions of Cameron Iron Works, Inc. J. G. Long was appointed general manager of the newly created forge and ordnance division and Hammond A. Helms was elevated to general manager of the valve and oil tool division.

At the same time J. B. Ogden was made director of industrial relations and C. G. Hayward, controller of Cameron Iron Works, Inc. Long joined Cameron in 1930. He was formerly factory manager.

Helms came to the company in 1944 and was director of materials and controller. Ogden was formerly legal assistant to the general manager and Hayward was assistant controller.

Reo Division Activated

Activation of the industrial and marine engine division of Reo Motors, Inc., was announced by Joseph S. Sherer, Jr., Reo president. Formation of the new Reo division has been in the planning stages for many months, Sherer said. The new division sales activities and engineering developments will be headed by R. D. Jacobs, II. Jacobs joined Reo in 1951 to assist in the preliminary groundwork.

Dravo Film Out

Dravo Corporation has completed a new 30-minute, 16-mm sound film in color documenting many of the firm's diversified activities serving nearly every segment of industry. Entitled "Portrait of an Enterprise," the movie typifies modern American industrial engineering firms. Emphasis is placed on engineering of all kinds.

Two Canada Offices Formed

Establishment of two division offices of Schlumberger Well Surveying Corporation in Canada under the supervision of the Calgary headquarters has been announced by W. J. Gillingham, executive vice president. R. C. Davis, district manager at Edmonton, Alberta, will head the new Western division office. He served in the Texas and Mid-Continent areas before going to Canada in 1951. D. M. Cowart will be manager of the Eastern division with offices at Regina, Saskatchewan. Cowart was transferred to Canada from Shreveport, La.

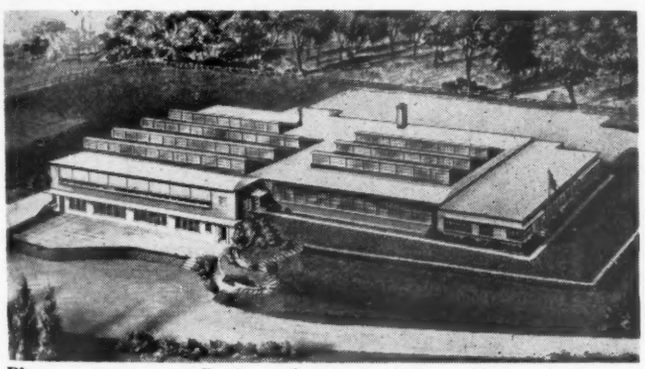
Youngstown Bulletin Noted

For the third straight year The Youngstown Sheet and Tube Company has been awarded a George Washington Honor Medal by Freedoms Foundation of Valley Forge, Pennsylvania, for its employee publication "The Bulletin." The award was among 761 announced at Valley Forge.

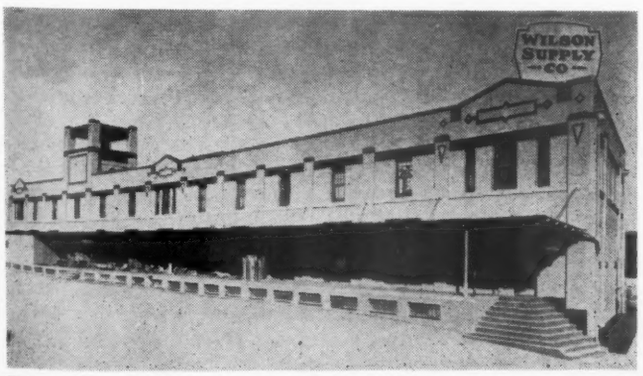
Bovaird Supply officers attending the company's recent sales and management meeting in Tulsa, Oklahoma, were: D. D. Bovaird, president; standing, Frank D. Bovaird, vice president; Roscoe G. Ayers, vice president and general manager of sales; Raymond E. Batchelor, general manager of stores; T. H. Trower, treasurer; R. M. McMahan, secretary and purchasing agent, and W. J. "Bill" Bovaird, assistant to the general manager of stores. All employees with more than 15 years' service were introduced.

Service awards totaling 120 years were made by Oil Well Division of U. S. Steel Corporation to above executives at the Los Angeles Petroleum Club recently. Donald S. Grubbs, California area manager, pins 40-year pin on Los Angeles sales representative Harry Cleeland as Warner Parker, area sales manager, 30 years; Bob Watkins, area engineer, 15 years; and H. L. Thomas, quoting and pricing specialist, 35 years, look on.

Ned Biffle, owner of the Biffle Drilling Company, who pilots his own Riley Twin Navion Conversion plane in far-flung business operations, alights at Fort Lauderdale, Florida. In this instance Biffle was on a pleasure trip, enroute to Miami.



Plant extension at Foxboro Company, Ltd., at Montreal, Canada, has more than doubled its instrument manufacturing facilities in Canada. New building adds 23,000 sq ft of factory space for production of instrument parts, assembly, etc.

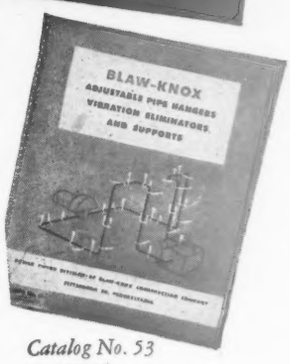


Wilson Supply Company recently moved into new quarters at 1301 Conti Street, Houston, Texas. New building is large enough to house varied business of the company.

All Movements Under Control with

BLAW-KNOX OVERHEAD ROLLER ASSEMBLIES

Type 9 Functional Assembly (illustrated) provides free rolling action in two directions and freedom of movement in three—lateral, vertical and horizontal. Its *internal swivel* action gives full control over all movements, and minimizes absorption of piping thrusts by the connecting flanges . . . a big help in keeping maintenance and replacement costs at rock bottom. Available for all standard size piping. Accommodates operating loads up to 12,000 lbs.

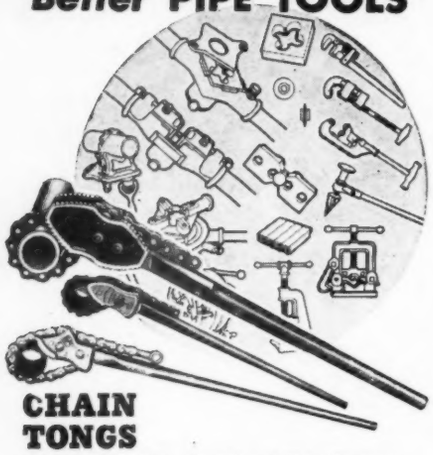


Catalog No. 53 on request.

POWER PIPING AND SPRINKLER DIVISION
BLAW-KNOX COMPANY
PITTSBURGH 33, PA.

BLAW-KNOX

ARMSTRONG BROS.
Better PIPE TOOLS



CHAIN TONGS

"Reversible," "Standard" and "Ideal" types in all sizes. Jaws are drop forged from special steel, are carefully milled, heat treated, hardened and tested. The *Handles* are forged spring steel. The *Chains* are proof-tested to ⅔ catalog strength (1,200 lb. to 40,000 lb.). "Reversible" Jaws give double jaw life. "Standard" Jaws have extra bearing on the handle and forged-in chain guides. The "Ideal" Tongs have V shaped teeth for a sure grip on irregular shapes — fittings, etc.

Write for Catalog

ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
231 W. ARMSTRONG AVENUE • CHICAGO 30, ILL.

"Houston's Welcome to the World"

- Completely air-conditioned.
- Businessman's hotel in heart-of-Houston location.
- Four fine restaurants, excellent cuisine.
- Famous Empire Room, nationally known orchestras, playing noon and night.
- New 1,000-car garage.
- Fabulous new PETROLEUM CLUB, entire top floor.
- Room rates: from $4.50 single, from $6.50 double.

B. F. ORR, *General Manager*

The Rice Hotel
HOUSTON • TEXAS

Officers recently elected by Web Wilson Oil Tools include: W. W. (Web) Wilson, board chairman; W. A. Wilson, president; B. M. Landis, vice president, and John W. Rife, secretary-treasurer. Officers were elected at a recent meeting.

Dallas Branch Established

Maintenance Engineering Corporation has opened offices in Dallas, Texas, it has been announced by C. E. Naylor, president. The new Dallas offices of the company will be in charge of James W. Campbell.

Situated at 211 Williams-Wanger Building, 1330 Industrial Boulevard, the new Dallas branch will handle sales of the company products.

Arkansas Plant Obtained

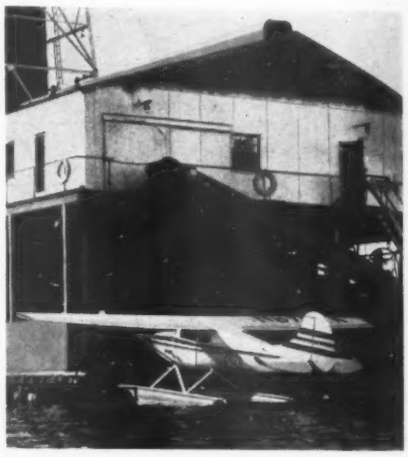
International Glass Corporation has recently purchased all the plant facilities and equipment of the Perrault Glass Fiber Corporation in Newport, Arkansas. Roy J. Scott, president of International Glass Corporation, announces that full production at the Arkansas plant will be resumed shortly. At the present time, engineering improvements are being made to produce a more complete line of products.

Name Changes Announced

The name "Midwest Piping and Supply Company, Inc.," has been changed to "Midwest Piping Company, Inc.," according to an announcement by A. G. Stoughton, president and chairman of the board of directors. Stoughton adds that there has been no change in ownership, management, personnel, or activities of the company.

B & W Plant Building Begins

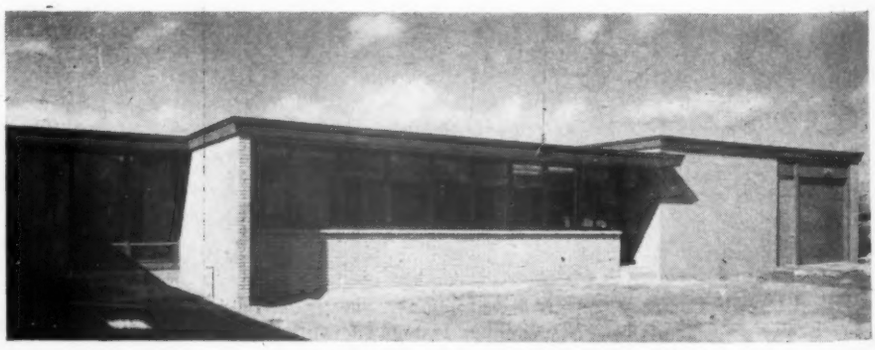
Babcock and Wilcox Company has purchased a tract of land south of the city of Wilmington, North Carolina, and will begin to erect a new $2,000,000 plant to build boilers and related equipment. It was announced that the new plant would mean that the company had more than doubled its productive capacity in the boiler division, in that the five new plants would be able to duplicate what the division could produce a year ago.



Technical Oil Tool Corporation's new Cessna 170 monoplane tied up to the Richardson and Bass, Rig No. 9, at Point a La Ha Hache, Louisiana. H. H. Peters, Totco, vice president, stated that the new Totco plane is based at Houma, and piloted by Totco's service representative, Bill Lunsford.

Rogers Lab Completed

Rogers Geophysical Company has recently completed a new $75,000 laboratory building at its home office at 3616 West Alabama, Houston. Of modern design to conform to the style of the office, the new lab is completely equipped for geophysical work.



ROGERS GEOPHYSICAL LABORATORY IN HOUSTON.

TRADE PERSONALS

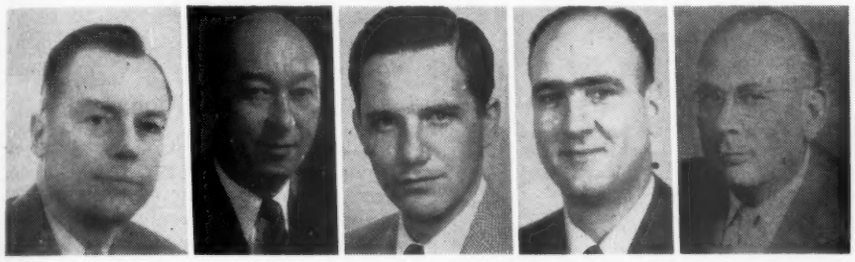
Chester A. Siver has been named general manager of engineering for Black, Sivalls & Bryson, Inc. Siver will have company-wide supervision of engineering activities, including engineering staffs in Kansas City, Oklahoma City, and Tulsa.

Before joining BS&B, Siver was manager of engineering, Liquid Carbonic Corporation.

R. L. Hanes has been named assistant to the vice president in charge of sales for Colorado Fuel and Iron Corporation. Hanes joined CF&I in 1929. In April 1949 he was appointed manager of wire product sales with offices in Denver, Colorado.

Morris Evans has been appointed to Cooper-Bessemer's regional office at Houston, Texas. Working under the direction of Robert Dale, branch manager, Evans will devote his efforts to engineering compressor installations for refinery operations. He is a graduate of Vanderbilt and Virginia Military Institute.

E. E. "Bill" Williams, Technical Oil Tool Corporation, export representative, is on a trip to Columbia, Venezuela, and Mexico. Williams, representing both Totco and the Lucey Export Corporation, will contact users of Totco Recorders and other products in Lucey's full line of equipment. He plans to return to this country in May.



C. A. Siver R. L. Hanes M. Evans L. L. Downing E. E. Williams

George A. Ellis has been appointed to the products engineering department of The Trane Company. Ellis' work at Trane will be chiefly on control application engineering and control systems used with Trane equipment.

Werner G. Wassmandorf has been named to the refrigeration sales department of Trane. His first assignments will be with the new Trane Company packaged water chiller and the hermetic compressor.

New appointments to Trane sales offices throughout the U. S. were announced recently by Thomas Hancock, vice president in charge of sales. All of the new Trane representatives are college graduates with degrees in engineering They are: **Bruce Adams, Anthony C. Del Vecchio, Roy Downham, Jacques F. Dreyfuss, Vernon T. Frankwich, Raymond O. Goodman, Orlin C. Hockin, Ted Kozerski, Robert L. Moore, Andrew K. Morris, Joseph D. Orlando, James A. Pohlman, Alfred R. Scarperi, Allen Skiles, Frank L. Vaughn, Wilfred R. Barnard.**

Scott Stahr, Cornell University, will be in the refrigeration department at the home office.

Also completing the 1952 Trane Graduate Training Program was **Kenneth MacDonald** of Johannesburg, South Africa. He has joined the J. L. Clark and Company of Johannesburg, distributor of Trane Company equipment in South Africa.

Other assignments are: **W. E. Hainline,** to the Des Moines office, and **Hugo D. Brown,** appointed to St. Louis. Both Brown and Hainline are graduates of the Trane Company training program.

L. L. (Len) Downing has been named Rocky Mountain sales representative for Cardwell Manufacturing Company, Inc. Downing came to Cardwell from Baash-Ross where he was Kansas representative for that firm.

Robert L. Ledeker has been named to represent Alten Foundry and Machine Works, Inc., in the state of Kansas. He previously covered Indiana, Illinois, and Western Kentucky for Alten.

R. F. Griffin C. W. Freeman

R. L. Ledeker

Ralph F. Griffin has been assigned to the tri-state territory including Indiana, Illinois, and Western Kentucky. He was formerly with Griffin Producing Company.

C. W. "Clem" Freeman now represents Alten and has the state of Oklahoma as his territory. He is a former supply company store manager.

D. R. (Dick) Dale, for many years chief engineer-metallurgist of The S. M. Jones Company, has retired as of March 1st. Dale became associated with The S. M. Jones Company in May, 1911. First employed as assistant superintendent, he became subsequently superintendent and then chief engineer-metallurgist.

C. C. Scott T. G. Judd H. F. Maloney, Jr. A. F. Campbell H. N. Williams

Cecil C. Scott has been appointed central Mid-Continent regional sales manager for Security Engineering Company. Scott will have charge of all Security sales in Texas, west of Abilene, as well as New Mexico, Colorado, Wyoming, and North Dakota territories. He joined Security in 1948.

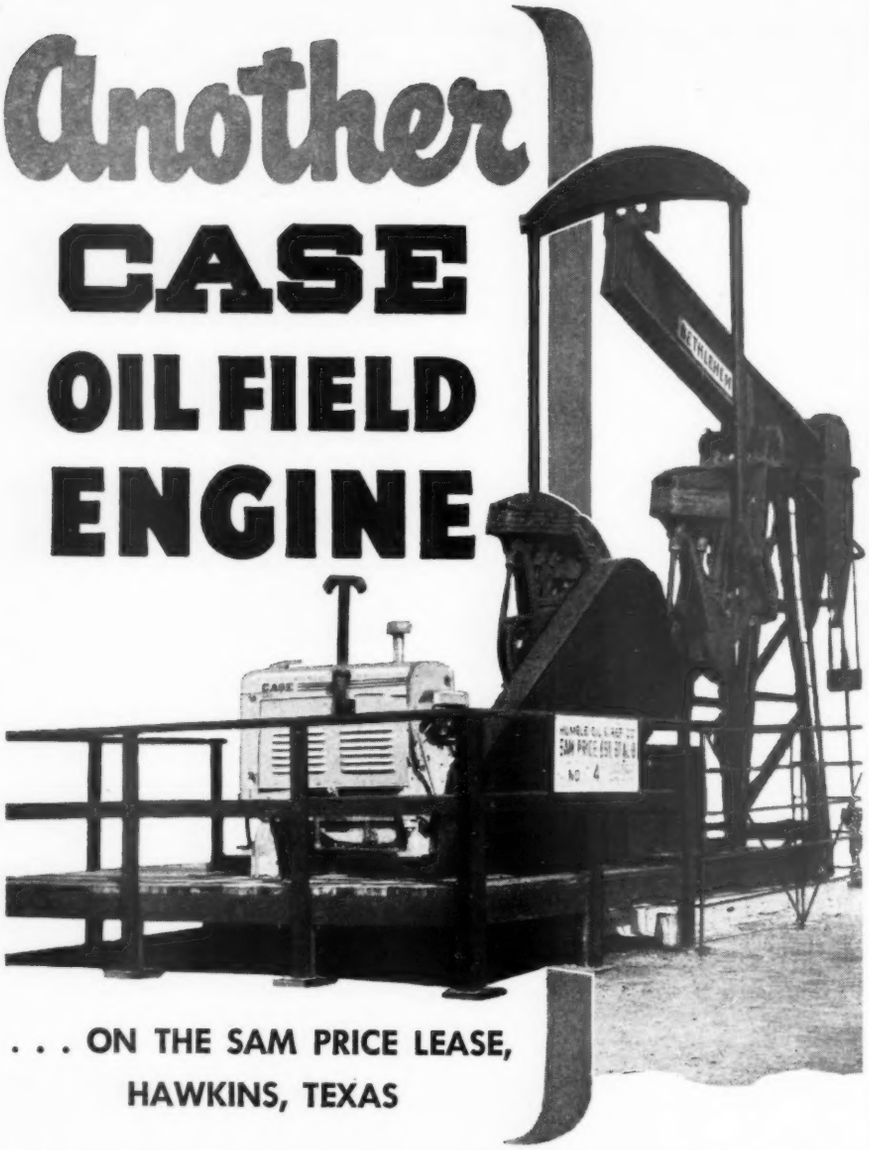
Thomas G. Judd has been named director of advertising and merchandising, Bonney Forge and Tool Works. Judd, a graduate of the University of Oregon, was advertising manager of Thermoid Company before his present appointment.

H. F. Maloney, Jr., has been promoted to manager of sales in the Cleveland, Ohio, district by Brown Fintube Company. A graduate of Ohio University, Maloney joined Brown in 1947.

Arch F. Campbell, manager of oil field sales of Detroit Diesel Engine Division of General Motors Corporation, spent the month of January and the early part of February in South America, working out of Caracas, Venezuela. Arch read about the ice and snow in his headquarters state, Oklahoma, and considered himself fortunate to be enjoying the sunshine of South America. He reported plenty of oil activity down there, and, of course, didn't overlook the many General Motors diesels in use.

Harry N. Williams has been made manager of warehouse sales for Flint Steel Corporation. He replaces **Homer Hofflander** who recently resigned. He comes to Flint Steel from Marsh Steel Corporation, of Kansas City, Missouri, where he was sales manager from 1945 until the present time.

Another CASE OIL FIELD ENGINE



. . . ON THE SAM PRICE LEASE, HAWKINS, TEXAS

LONG, CONTINUOUS SERVICE LESS CARE AND ATTENTION

Reports of Case Oilfield Engines running non-stop for months on end make news now and then. Runs of such length may seldom be called for. But when they happen, they reflect the stamina and endurance that enable these sturdy engines to go a long time before overhaul, with a minimum of routine attention. Oil men also like the flat torque-curve of Case Engines, which enables them to carry normal load at reduced speed. It permits adjustment of pumping rate without change of pulleys or other parts. Four sizes, 24 to 61 H.P., offer good matching of engine to its task. J. I. Case Co., Racine, Wis.

CASE

Trade Personals

Lyle L. Payne has been promoted to assistant vice president—engineering, for Hughes Tool Company. **R. S. Grant** has been appointed chief product engineer, in charge of the product engineering department, to fill the vacancy created by the promotion of Payne. **A. P. Farr** has been appointed assistant chief product engineer.

L. L. Payne

R. S. Grant

A. P. Farr

William R. Graydon has been named copywriter to service Hill & Christopher's petroleum and other industrial accounts. Graydon, formerly of the Los Angeles Mirror, specialized in writing industrial features that ranged from electronics and geophysical stories to heat-treating and plastics manufacturing.

W. R. Wheeler, Jr., has recently been promoted to the newly created position of assistant sales manager of American Iron and Machine Works Company of

J. M. Taylor

W. R. Wheeler, Jr.

Oklahoma City, Oklahoma. Prior to this Wheeler was special sales representative at Tulsa.

Replacing Wheeler will be **J. M. Taylor.** Before moving to Tulsa Taylor was export manager for the company in New York City.

J. C. Freyberg has been named advertising manager of Panellit, Inc., and its two associated companies, Panalarm Products, Inc., and Panascan, Inc. For the past nine years, Freyberg has been with Wheelco Instruments Company.

A. L. Danielson has been named manager of Bailey Meter Company's branch office in Denver, Colo. He succeeds **G. M. Wallace,** who has recently been appointed an assistant sales manager with headquarters in Cleveland.

Trade Personals

E. H. Bradley

G. W. Kelsey

Earl H. Bradley has been named president of Builders Iron Foundry to succeed Henry S. Chafee who will remain with the company as treasurer of the company. Chafee joined Builders Iron Foundry in 1909 and became president in 1944. Bradley, who joined Builders in 1934, was appointed executive vice president in 1949.

George W. Kelsey was elected president of Builders-Providence Inc., recently. BPI is the instrument division of Builders Iron. Kelsey joined Builders in 1938.

William B. Morse, formerly assistant to the manager of the Detroit, Michigan, sales and service branch of Fairbanks-Morse, has been appointed manager, succeeding **E. J. Hay,** deceased.

Morse is a great grandson of the founder of the company and son of Robert H. Morse, Jr., president. He has been with the company since 1946.

B. R. Eng, who has been with the company for many years, was appointed assistant comptroller. **J. E. McQuilkin,** general auditor, has moved to Montreal, Canada, where is is now assistant to the president of The Canadian Fairbanks-Morse Company Ltd. **Frank M. Mason, Jr.,** formerly director of engineering, has been appointed coordinator of United States Government Business.

J. F. Weiffenbach, formerly vice president in charge of manufacturing of the Canadian Locomotive Company, Ltd., has been appointed chief product engineer, manufacturing division, in Chicago.

W. E. Watson has been assigned works manager, Canadian Locomotive Company, Ltd., Kingston, Canada.

J. R. Walsh, who has since 1948 been manager of the Stuttgart, Arkansas, works, has been promoted to manager of the company's new plant now nearing completion in Kansas City, Kansas.

W. P. McAnally, formerly supervisor of production at Stuttgart, succeeds Walsh as manager of the Stuttgart Works.

Irwin Colman has been appointed to the post of assistant sales manager in charge of hydraulic components, both industrial and aircraft of Greer Hydraulics, Inc. Prior to his association with Greer, Colman held the rank of Lieutenant-Commander in the U. S. Navy.

John H. Kilmer, Jr., has been appointed chief engineer, and **Paul A. Brauer,** assistant chief engineer in charge of production of Golden-Anderson Valve Specialty Company. Both Kilmer and Brauer have been associated with the company since 1938.

H. L. Taylor

W. A. Dunn

Harry L. Taylor of Pittsburgh has been appointed sales manager of Spang and Company. Taylor, a native Pittsburgher, is well known in industrial circles, having been in the sales division of Carnegie-Illinois, now U. S. Steel, for the past 30 years.

Walter A. Dunn, traveling representative for R. S. Stokvis and Sons, Inc., left early in February for a planned two-month business trip to South America, to call on oil and geophysical company personnel operating there. He plans to return to New York in April following his tour of Peru, Ecuador, Colombia, Venezuela, and Trinidad.

E. O. (Steve) Owens and **Don L. Long** have been appointed sales and

E. O. Owens

D. L. Long

service engineers for T. D. Williams, Inc. Owens, graduate of Oklahoma A & M has been assigned to Oklahoma, Arkansas, Missouri, Kansas, and the eastern half of Nebraska.

Long, a graduate of Oklahoma University, engineering, will cover miscellaneous states.

T. W. Painter and **Blake M. Caldwell** have been elected vice presidents of Welex Jet Services, Inc. Painter was named vice president in charge of operations. He was formerly supervisor of

B. M. Caldwell

T. W. Painter

manufacturing and later operations manager. Caldwell was named vice president in charge of engineering. He has been instrumental in the further development of the Jet process as well as related tools.

Automatic Lincolnweld doubles production

IT used to take 15 minutes to hand weld a tool joint to drill pipe. Now by "Automatic Lincolnwelding", this time is cut in half . . . an increase in production of 100%. Here's how:

The drill pipe is raised to a position approximately 15 degrees from vertical and held in a fixture which rotates the joint at the predetermined speed beneath a continuously fed electrode. Granular flux for "hidden arc" automatic welding is held in place with a simple dam. The tubular joints are SAE 4140-45 steel and the pipe is carbon steel. Welding speeds are approximately 22" per minute at currents of 450 to 475 amps.

Two separate welding machines handle the pin end and box end. Actually the box end is welded in three passes in 5 minutes, 50 seconds. The pin end is completed in 6 minutes, 53 seconds including all necessary handling to complete the welds.

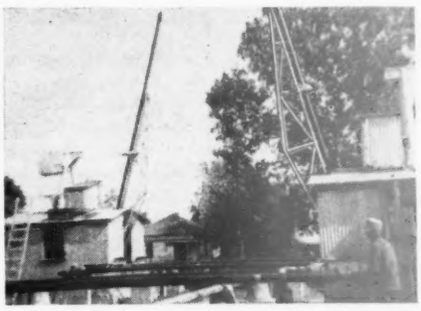


Fig. 1. Drill pipe *with joint bucked up is elevated into position for fillet welding tool joint to pipe.*

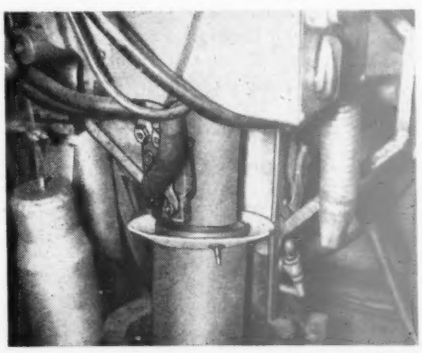


Fig. 2. Low cost *Automatic Lincolnwelding of tool joint to pipe. Pipe is turned at preset speed as continuous electrode is fed into work. Arc is hidden beneath granular flux.*

Photos courtesy American Iron & Machine Works Company, Oklahoma City, Oklahoma.

FULL DETAILS on speeding welding operations and cutting welding costs with "Automatic Lincolnweld" are in Bulletin 439. Write on your letterhead to Dept. 2804.

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio

THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

Trade Personals

▸ **Dr. Arnold O. Beckman,** president and founder of Beckman Instruments, Inc., was one of two men appointed to the board of trustees of the California Institute of Technology. An Institute associate since 1948, Dr. Beckman is the first alumnus elected as trustee. He received his doctorate in chemistry from the Institute in 1928 and served on the faculty from 1929 to 1940.

▸ **James R. McCutcheon, Jr.,** has been appointed sales manager of the valve division of Homestead Valve Manufacturing Company. He received his early sales training with National Tube Company, and for the last seven years he has served as district representative for American Car and Foundry Company.

▸ **R. B. Warren,** former Southern sales manager, has been named manager of industrial products departments, Goodyear Tire and Rubber Company. **L. W. Adams** has been promoted to Warren's former post as Southern sales manager, industrial products division. Warren joined Goodyear in 1927. Adams, who has been Pittsburgh district manager for Goodyear's industrial products division since 1949, joined Goodyear in 1943.

R. B. Warren

L. W. Adams

▸ **L. A. Dixon,** Rockwell Manufacturing's executive vice president, has been given jurisdiction over the company's power tool operation. Rockwell's power tool operation includes the Delta Power Tool Division, Rockwell Tools, Inc., and the Deluxe Saw and Tool Company.

P. C. Kreuch

C. C. Shenkle

C. C. Moore

W. S. Andrews

G. T. Bowman

▸ **Paul C. Kreuch** has been named assistant to vice president in charge of sales and **Courtney C. Shenkle** as assistant to vice president in charge of manufacturing for Rockwell Manufacturing Company. The appointments are part of a reorganization program made necessary when L. A. Dixon, vice president, meter and valve division, assumed full responsibility for all sales and manufacturing departments of this division, January 1.

Carl C. Moore has been named as central regional manager of sales and **W. S. Andrews** as district manager of the Pittsburgh district of Rockwell. Andrews, former district manager of the New York area, is replacing Moore as district manager. He was formerly with Beaver Pipe Tools, Inc.

Gilbert T. Bowman was recently appointed as sales manager of both the Nordstrom and gas products divisions of the company. Bowman joined Rockwell in 1939, becoming sales manager of gas products in Pittsburgh in 1951.

▸ **Walter H. McCann,** an employee of The National Supply Company since 1936 has been appointed supervisor of tubular sales for its Eastern division. He succeeds **Walter Wirth,** who retired recently after 43 years service. McCann became chief tubular clerk in 1948.

J. W. Bozeman

▸ **J. W. Bozeman** has been named president of Tuboscope Company and other officers are **B. H. Pickard** and **Harry Bozeman,** vice presidents, and **H. E. Berry,** secretary-treasurer, following recent reorganization of the company. Policies of the company will not be affected in any way by the new set-up, Bozeman said.

▸ **J. Sidney (Sid) Broom** has been appointed fishing tool service engineer at the McCullough Tool Company's Vernal, Utah branch. During the past year Broom has been working out of the McCullough Los Angeles headquarters as a fishing tool service engineer.

▸ **H. C. "Buz" Sawyer** and **L. E. "Ed" Wallace** have been appointed regional sales managers for Orbit Valve Company. Sawyer, who has been Mid-Continent district manager in Tulsa since 1949, is being transferred to Midland, Texas, as regional sales manager. Wallace was made a district manager in March 1952, at Corpus Christi and transferred to Houston in that capacity October 1952.

H. C. Sawyer

L. E. Wallace

E. F. Bentley

R. V. Baxley

L. A. Steele

J. C. Campbell

▸ **Ernest F. Bentley** has been named general sales manager of the Detroit Diesel Engine division of General Motors. Bentley succeeds V. C. Genn whose death occurred in January. Bentley's association with General Motors dates from 1934.

Other appointments that have been announced by Bentley, include **Robert V. Baxley,** as operations sales manager; **John C. Campbell,** as manager of manufacturer's sales, and **Louis A. Steele,** as industrial sales manager.

▸ **Wallace A. Gray** has become a member of the New York sales staff of The Girdler Corporation's votator division. Gray joined Girdler in 1944. In 1950 he was assigned to the field service and engineering staff.

▸ **H. J. (Herb) Howerth, Jr.,** has been named assistant sales manager of the Wayne division of Gar Wood Industries, Inc. Howerth served as chief sales engineer for the Wayne division until his recall to military service two years ago.

▸ **L. C. Perkinson** was elected vice president and **G. C. Walker** treasurer of American Cyanamid Company. Perkinson, who has been with Cyanamid since 1921, had been treasurer of Cyanamid since 1945 and a director since 1946. Walker had been assistant treasurer since 1951.

▸ **Frank C. Sterling** has been transferred by The Youngstown Sheet and Tube Company from its Yoloy sales office here to its district sales office in Pittsburgh, Pennsylvania. Sterling attended Ohio State University in Columbus and Youngstown College.

He joined The Youngstown Sheet and Tube Company in 1936.

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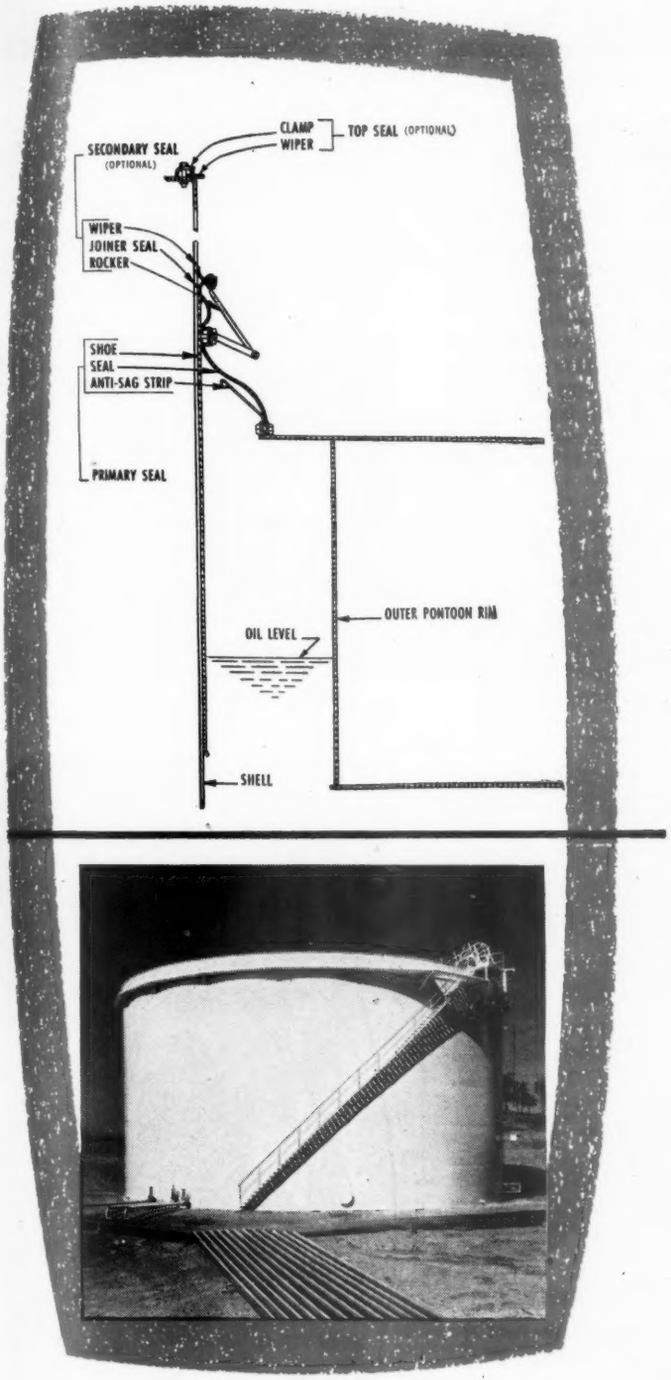
number 1 of a series



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top seal—stops vapor losses when roof is operating in upper 3 feet of tank. You get full tank capacity without increasing shell height. A patented Wiggins exclusive feature.

secondary seal—Neoprene-coated fabric ring and joiner curtain cuts costly wind losses. Saves 50% of evaporation losses suffered by tanks having only a single seal.

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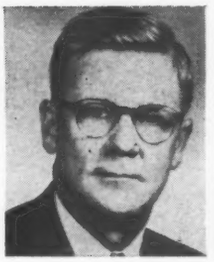
Trade Personals

M. W. Rhoten

C. Crozier

W. A. Hebeler



W. S. Barackman, Jr.

R. H. Windbigler

R. E. Bruse

▸ **Myron W. Rhoten** has been named territory sales manager for the European area, tractor division, Allis-Chalmers Manufacturing Company. He succeeds **George A. Gillespie,** recently appointed resident manager of the company's Paris, France, office. Rhoten is succeeded as export service manager in the home office of the company by **Clyde Crozier** who has been on his staff since 1951.

Walter A. Hebeler has been appointed to the newly created position of export sales manager, tractor division, Allis-Chalmers. Hebeler has been a special export representative for the tractor division since 1950.

W. S. Barackman, Jr., is branch manager at Dallas for the tractor division, Allis-Chalmers, succeeding **A. J. Simpson,** retired. **R. H. Windbigler** succeeds Barackman as industrial sales manager at Dallas.

Ralph E. Bruse is announced as branch manager at Amarillo, Texas, succeeding **Charles W. Baker,** retired. In this position, Bruse supervises sales for the tractor division's complete line of products.

▸ **William A. Moore,** manager of U. S. Steel's Oil Well Supply Division's branch store at Avenal, California, for the past five years, was appointed district representative in the San Joaquin Valley district and **Paul S. Paulsen** was named to succeed him as store manager at Avenal. In his new position, Moore will serve the Western part of the San Joaquin Valley.

Paulsen was formerly a field representative at Avenal.

▸ **C. Lynn Frost** has been appointed advertising manager of Hewitt-Robins Inc. Frost joined Hewitt-Robins as assistant advertising manager in 1949. He attended the Night School of Business of Temple University, and is a graduate of the Charles Morris Price School of Advertising and Journalism.

▸ **Morvin "Mike" Thomas** of the Morvin Thomas Company has been named representative for Shortstir side entering mixers in the Oklahoma, Texas Panhandle-Southern Kansas, and Western Arkansas areas. Morvin Thomas Company offices are in Tulsa, Oklahoma—suite 310 Thompson Building.

▸ **J. K. Henderson** has been promoted to the position of chief field engineer for Dowell Incorporated. He will be stationed at the company's general office in Tulsa, Oklahoma. Prior to his transfer he was district engineer for Dowell at Wichita Falls, Texas. A graduate of University of Oklahoma, he joined the Dowell organization in 1947.

J. K. Henderson

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Complete Power Unit with Clutch Reduction.

The NEW Model VG4D 25 to 36 H.P.

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Another engineering achievement . . . the NEW Model VG4D V-type 4-cylinder Wisconsin Heavy-Duty Air-Cooled Engine, increasing the power range to 36 hp. — a power gain of more than 16% over the VP4D, former top engine in the line.

The NEW Model VG4D is an exceptionally smooth-running, even-firing engine. Its light weight and compactness in design simplify the problem of engine installation on modern equipment where weight and space limitations are important factors.

Every one of the traditional Wisconsin 4-cylinder features are built into this new model. These include, to name a few, tapered roller main bearings, dynamically balanced forged crankshaft, mirror finish on crank pins, Stellite-faced exhaust valves and valve seat inserts and honed cylinders for long, dependable, heavy-duty engine life.
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TULSA'S FINEST HOTEL
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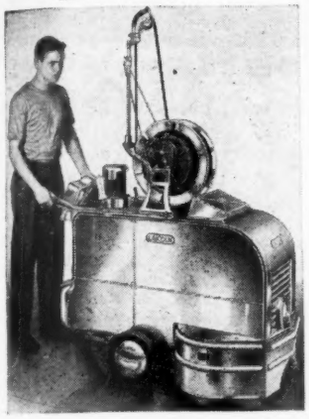
These Special LINCOLN Machines will Scrub, Wax and Polish Your Laboratory Floors to Shining Cleanliness with Absolute Safety!!



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ELM GROVE STATION — WHEELING, W. VA.

Trade Personals

W. J. Lytle, who has been serving as Permian Basin division manager at Midland, Texas, for Schlumberger Well Surveying Corporation, has been transferred to Fort Worth as assistant area manager for Northwest Texas. He is a veteran of 15 years with Schlumberger. Replacing Lytle in Midland will be **George Decker.** Decker has been Kansas division manager since 1950.

R. K. Forsythe will replace Decker as Kansas division manager at Wichita. He was formerly in Calgary, Alberta. **H. W. True** has been appointed South Louisiana division manager. He replaces **H. A. Nystrom,** who was recently transferred to the Houston office. True was formerly Mississippi division manager at Jackson.

New manager of the Mississippi division is **T. A. Morris.** An employee of Schlumberger since 1937, Morris was district manager at Harvey, Louisiana, before his appointment.

Peter J. Totino has been named chief process planner, in the manufacturing division of Consolidated Engineering Corporation. Totino was graduated from New York City College in 1939.

Hugh F. Colvin has been named vice president and treasurer of Consolidated Engineering Corporation. Graduating from Harvard, Colvin was associated with the Wilshire Oil Company and then Union Oil Company.

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SHALE SEPARATOR AND SAMPLE MACHINE
PROVED 8 WAYS
1. REMOVES DESTRUCTIVE SHALE AND ABRASIVES FROM MUD
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SOLD ONLY THROUGH SUPPLY STORES
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IOWA PARK, TEXAS

Arthur J. Elbert, Jr., has been appointed manager of sales—pipe lines, a newly created position in the general sales department of U. S. Steel's National Tube Division. Elbert has been with National Tube since 1937 when he began as a laborer at the company's Christy park works at McKeesport, Pennsylvania.

Arthur J. Elbert, Jr.

Ralph E. Clarridge became chief engineer for Taylor Instrument Companies recently, replacing **Karl H. Hubbard** who was made technical director. Hubbard is also a member of the board of directors.

Replacing Clarridge as manager of the application engineering department is **George E. Howard,** formerly assistant manager.

Other changes involve **Robert D. Thompson,** named division head in charge of research, design, methods, and technical sales in the Glass Products Division; **Laurence C. Liberatore, Donald W. Shepardson,** and **James R. Davidson,** all made engineering section heads.

W. E. Wagner

William E. Wagner has joined C-R-C supply division as a representative in the Houston area. He comes to C-R-C from Charles Wheatley Company, where he worked for five and one-half years in the Tulsa Oklahoma, and Houston, Texas, areas. C-R-C Supply is a division of Crutcher-Rolfs-Cummings, Inc.

M. J. Harper has been named vice president and **H. Gottwald** eastern regional manager of sales and district manager of New York district office, Rockwell Manufacturing Company. Before his new appointment, Harper was regional manager of the Eastern region, coordinating the activities of the Boston, New York, and Philadelphia offices. His headquarters will be in new York City.

Gottwald joined Rockwell in 1928. For the last two years he has been general sales manager for the Nordstrom valve division.

E. P. Roudebush has been promoted to vice president and works manager of Roots-Connersville blower division of Dresser Industries, Inc. He will be in charge of all manufacturing activities at the Connersville, Indiana, and Delaware, Ohio plants. He is former works manager. **D. A. Johann** has also been promoted to vice president in charge of sales. He will be in charge of all sales and advertising activities of the company. He has been general sales manager since 1951.

Trade Personals

Paul Bowen

Paul Bowen was recently appointed president of S. R. Bowen Company, succeeding the late Jack Wilcox. Bowen is the son of S. R. Bowen, founder of the company. He began in the Bowen office in 1930. For the past several years he has been president of Bowen Fishing Tool Company and vice president of S. R. Bowen Company.

H. C. Allington has been elected vice president in charge of sales of the Eastern division of The Colorado Fuel and Iron Corporation. Allington has been general manager of sales of the Wickwire Spencer Steel Division of Colorado Fuel and Iron since 1947.

L. A. Watts has been named general manager of sales of the Eastern division. He has been assistant general manager of sales of the Wickwire Spencer steel division since 1951. A graduate of Northwestern University, Watts joined the then Wickwire Spencer Steel in 1938.

Harold D. Newell has been appointed consulting metallurgist and **John J. B. Rutherford** chief metallurgist of the tubular products division of The Babcock and Wilcox Company. Newell has been chief metallurgist since 1927 and in his new post will be relieved of detail work in connection with the supervision of the research section of the laboratory in order to devote his time to specific metallurgical problems.

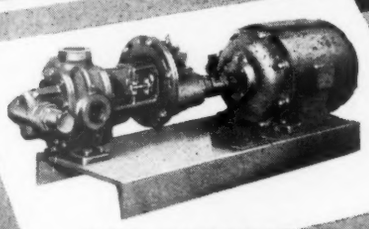
John W. Jacoby has been named manager of pump fluid end parts sales for U. S. Steel's Oil Well Supply Division. Jacoby joined "Oilwell" in 1943 as a design engineer at Imperial Works, Oil City, Pennsylvania. In 1949 he was transferred to Dallas as assistant to director of engineering.

Gordon A. Zwissler, former superintendent of Kaiser Steel's blooming and structural mills and the auxiliary soaking pits and conditioning yards operations, has been advanced to the position of division superintendent, rolling. Zwissler's new responsibilities will include operations of the company's electric weld and continuous weld pipe mills, blooming and structural mills, cold rolling mill, and the merchant-skelp mill.

Reynold C. MacDonald has been named to succeed Zwissler as superintendent of the blooming and structural mills at Kaiser Steel. MacDonald, formerly assistant superintendent of the company's merchant and skelp mills, will in addition be responsible for conditioning yard and crane department functions.

C. A. MacIlvaine has been named as assistant controller of Kaiser. MacIlvaine has served as division manager, general office accounting, in Oakland for the past year, and prior to that was office procedures and service manager at the Fontana Plant.

EFFICIENCY + PLUS



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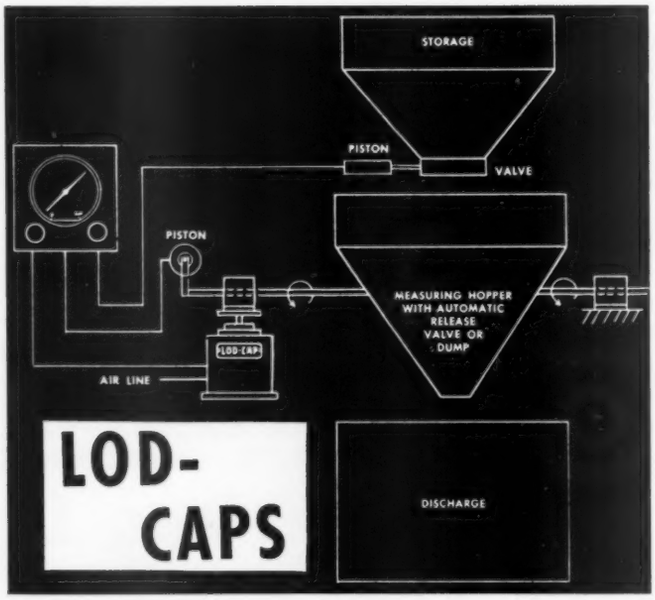

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BOOKS

▸ **Studies of Organic Limestones and Limestone Building Organisms.** *Quarterly of the Colorado School of Mines, Vol. 47, No. 2, April 1952. Compiled by J. Harlan Johnson, Department of Geology. Pages, 94. Price, $1.50.*

A geological presentation of various studies that were conducted on limestones from certain areas. The following are discussed: Modern mollusks, Ordovician rock building algae, middle and lower Pennsylvania of Kansas, Pennsylvanian reef in Terry County, Texas.

▸ **Petroleum Production Engineering,** *Third Edition, by Lester C. Uren. Published by McGraw-Hill Book Company, 330 West 42nd Street, New York City. Price, $10. Pages, 807.*

This volume is concerned with the technology and engineering problems involved in extracting petroleum and natural gas from nature's reservoirs, and with the handling and processing of them after they reach the surface. It is designed primarily to serve as a text and reference for petroleum engineering students in a course on petroleum production methods. It will also be helpful to those who may wish, in a single volume, methods and equipment employed in oil and gas production.

▸ **Permian Basin Oil Directory,** *by Burl H. Self. Published by Burmass Sales Company, Box 509, Midland, Texas. Price, $3.50. Pages, 456.*

This is a comprehensive listing of the oil industry of the Permian Basin with its key operating personnel. Two headings have been made under the producers tab, including oil companies, corporations, independent operators, lease and royalty men, independent producers, consulting geologists, and petroleum engineers. Service companies are listed under regular headings.

▸ **Radioisotopes in Industry,** *edited by John R. Bradford. Published by Reinhold Publishing Corporation, 330 W. 42nd Street, New York City. Price, $8. Pages, 309.*

This book is based on a series of lectures presented at Case Institute of Technology, and covers all the important industrial uses of radioactive isotopes. Original material was amended to include most recent developments and now represents a succinct compilation of the most-up-to-date available information on this field. The book includes numerous pictures, tables, and graphs, and covers not only the many uses of radioisotopes, but also such related topics as labororatory construction, shielding, personnel protection, handling techniques, etc.

▸ **Construction and Application of Conformal Maps,** *National Bureau of Standards Applied Mathematics Series 18, Government Printing Office, Washington 25, D. C. Price, $2.25. Pages, 280.*

This volume contains reports on the theory and applications of conformal maps prepared by scientists from universities and industries and presented at a symposium held in the summer of 1949 at the National Bureau of Standards Institute for Numerical Analysis, Los Angeles. Among the reports are detailed discussions of industrial applications, applications to electric and magnetic fields, elasticity, fluid dynamics, supersonic flows, and so on. Methods for the practical construction of conformal maps, including graphical methods, network methods, relaxation methods, the use of electrolytic tanks, and other more technical methods, are presented.

▸ **Saudi Arabia,** *Second Edition, by K. S. Twitchell. Published by Princeton University Press, Princeton, New Jersey. Price, $5. Pages, 231.*

First published in 1947, this book is now brought up-to-date through mid-1952. This edition includes revision of factual data throughout the text, a new chapter entitled "Developments Since 1946," and 50 pages of new illustrations. The new chapter is particularly concerned with developments in Saudi Arabia in oil and in transportation. This chapter includes a table of oil fields and wells completed in the field. It also gives data on barrels produced, sold, refined, etc.

New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card

(A) RUBBER VALVES

Hycar rubber valves have now been used in over 1,000,000 liquefied petroleum gas regulators manufactured by Fisher Governor Company, the company reported. These inner valves insure the proper operation of the pressure-reducing regulators that are used in rural propane or butane gas tank fuel systerms. Two valves are used in each automatic change-over regulator.

Circle letter (A) on reply card.

(B) PIPELINE DRILLING RIG

The Joy "Hydrojib" pipeline drilling rig, a self-contained unit for drilling blastholes on either right-of-way or ditch work, has recently been announced by Joy Manufacturing Company. The "Hydrojib" rig carries two Joy 3½-in. rock drills on 6-ft chain-type feeds mounted on 10-ft hydraulically actuated Joy Hydro drill jibs.

Circle letter (B) on reply card.

(C) GAGING HATCH

The Enardo Manufacturing Company recently began shipments on a new gaging hatch designed for tanks where toxic gases constitute a personnel hazard. Already in use in the West Texas sour crude fields, the Enardo Series 300 safety gaging hatch gives positive protection against hydrogen sulfide and other harmful fumes and speeds up the entire gaging operation. This device consists of a gage opening, vent pipe, and a swing check valve.

Circle letter (C) on reply card.

(D) INDICATOR CARDS

Humidity indicator cards with "Tel-Tale" spots for use in dehydrated packaging are being introduced by The Davison Chemical Corporation. Changes in moisture conditions cause the spots to change color very rapidly and they indicate relative humidity reliably. The cards are inexpensive, and have had Air Force and Signal Corps approval.

Circle letter (D) on reply card.

(E) TURBOCHARGING

Waukesha Motor Company has extended turbocharging to relatively small engines. Turbochargers have been applied to five basic diesel engine sizes, three for transportation or industrial service and the two largest as complete power units for industrial service. The 1197 cu in. model is supplied either as a bare engine or complete unit. Turbocharged ratings represent power gains from 147, 200, 225, 298, and 406 hp.

Circle letter (E) on reply card.

(F) WEIGHT SYSTEM

A new method of supporting truck, truck-trailer, and bus bodies on air cushions has been designed by Weber Instrument Company, as a means of weighing a load anywhere en route, and to provide a safer, more stable ride. The vehicle is maintained level, regardless of improper or unbalanced loading, and at constant height, loaded or unloaded. Increased air pressure automatically compensates for undue depression of an air cushion. A gage provides accurate weight readings.

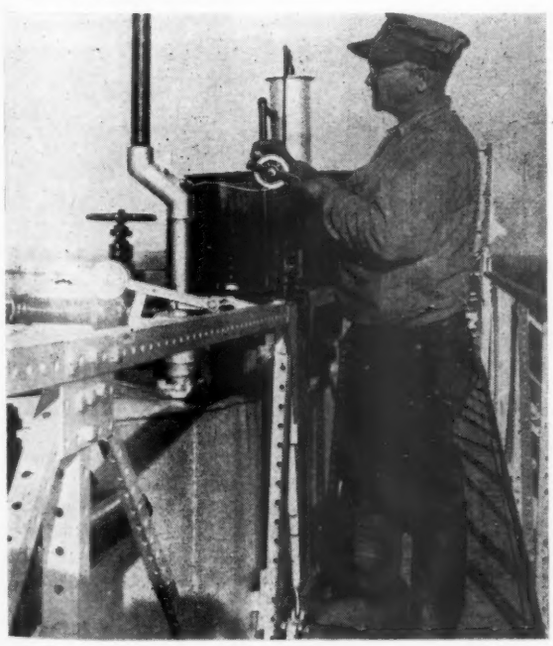
Circle letter (F) on reply card.

(G) ROSIN CORE SOLDER

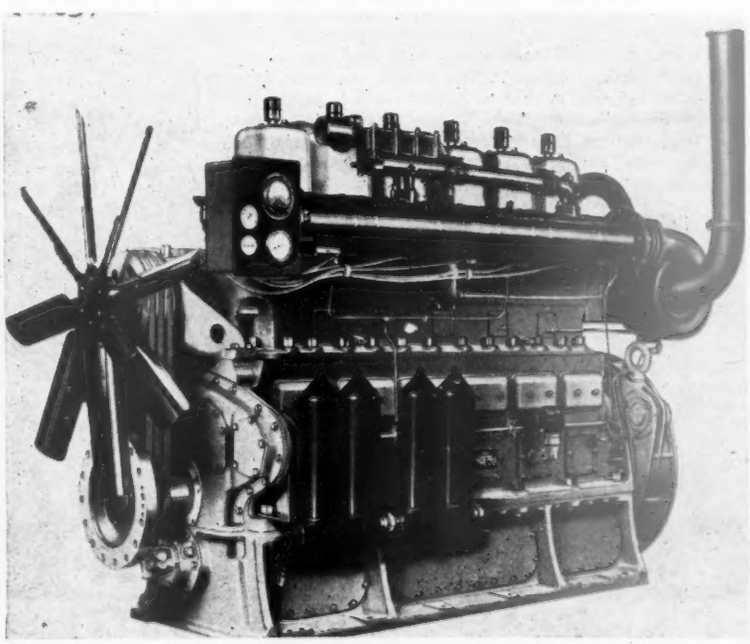
A new rosin core solder, active yet non-corrosive, has recently been developed by Federated Metals Division, American Smelting and Refining Company. Known as TS 200, it has been proved in production operations to have many advantages over ordinary rosin solders. Tests show that the spread of Federated's solder is 30 per cent greater that that of conventional rosin core solders. Oxide films and corrosion products on the parts being soldered need not slow down operations, because this solder pierces such agents faster than ordinary solders, it was reported.

Circle letter (G) on reply card.

Enardo gaging hatch.



Waukesha motor turbochargers applied to smaller engines.



Eagle-Picher officials place pressure vacuum molding equipment into operation. They are: Don Nash, Walter D. Myers, Herman Holster, Glen J. Christner, Alton Jones, Dr. Paul Thompson, and George Spiva.

(H) INSULATING BLOCKS

Glen J. Christner, vice president and general manager of Eagle-Picher's Insulation division recently announced that the company's new process for producing industrial high temperature insulating blocks is now under way. The blocks, produced by this new process, are known as Supertemp "P.V." (pressure vacuum) insulating blocks. They represent more than two years of development by Eagle-Picher.

Circle letter (H) on reply card.

(I) PRESSURE TANK

A new series of chemical injectors with welded steel pressure tanks are now available from Texstream Corporation for use with viscous or volatile liquids. The tank permits chemicals or additives to be forced from the container to the injector heads under constant pressure, to assure proper loading of the suction and to prevent volatilization and waste of alcohols and similar fluids.

Circle letter (I) on reply card.

(J) VALVES

A new design of cylinder-operated quick-acting valves has been developed by Everlasting Valve Company. The new design may be actuated by air or other fluid, can be regulated for operation at any speed, and also remote controlled electrically or manually. The valves permit automatic cycle operation and multiple operation by one man; power control eliminates operator fatigue.

Circle letter (J) on reply card.

(K) JET FUEL VALVE

A bellows-sealed diaphragm motor valve, originally designed for use in testing jet aircraft engine fuels, has been successfully applied to other volatile and toxic mediums by the valve division of Minneapolis-Honeywell Regulator Company. The pneumatically operated valve (listed as Type 27) handles flowing mediums such as gasoline, water mixtures, alcohols, ethers, ketones, kerosine, jet fuels, etc.

Circle letter (K) on reply card.

(L) NEOPRENE PAINTING

The Pennsylvania Salt Manufacturing Company has introduced a new system of anti-corrosion coating using specially formulated neoprene coatings. The special formulations, added to Pennsalt's regular line of corrosion resistant paints and cements, are NeoCoat and NeoPrime A (for all surfaces except concrete) and NeoPrime B (for concrete surfaces).

Circle letter (L) on reply card.

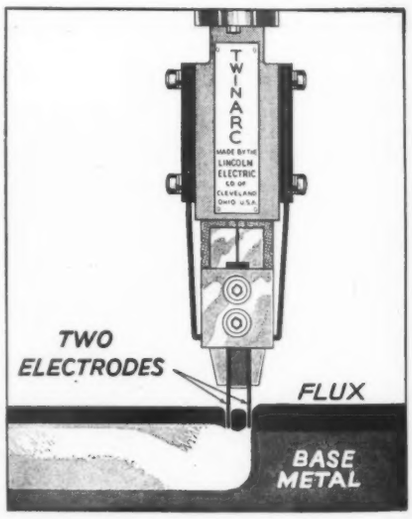
(M) FREE PUMP

A new development in the production end of the oil business is the Kobe free pump used for pumping oil wells after they have ceased to flow. A Kobe free pump consists of a double acting hydraulic engine directly connected with a pump that is also double acting. Entire unit is in the bottom of the oil well and hydraulic power, generated, and controlled from the surface, is piped down to operate its hydraulic engine.

Circle letter (M) on reply card.

(N) TWINARC WELDING

A new development in the application of hidden arc or submerged arc welding, announced by Lincoln Electric Company, is said to increase the speed of automatic welding from 50 per cent up.



Twinarc welding, as the development is called, employs two small electrodes in place of a single larger electrode. The two electrodes are fed simultaneously through a single head and a single jaw. Both electrodes deposit metal in the weld crater.

Circle letter (N) on reply card.

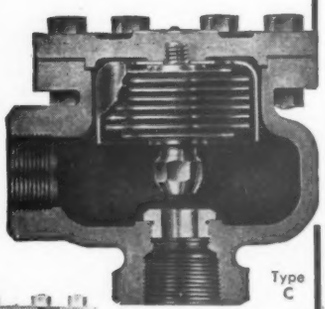
Leading Processor

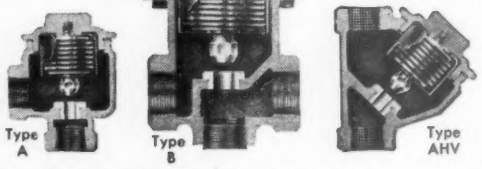
SHORTENS OPERATION

from 65 to 45 Min.

with Nicholson Steam Traps

Records of a recent installation of Nicholson steam traps, by a large processor, show they cut heating cycles 30%; e.g., one operation was shortened from 65 to 45 min. Nicholson units keep equipment full of live steam because: 1) they operate on lowest temperature differential; 2) have 2 to 6 times average drainage capacity. Also record low for steam waste; and maximum air-venting capacity. Widely specified for preventing damage to thin gauges; eliminate cold blow in unit heaters.





5 TYPES FOR EVERY PURPOSE — Size ¼" to 2"; pressures to 250 lbs. **BULLETIN 152.**

HIGH-PRESSURE FLOATS — Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. **BULLETIN 650.**

217 OREGON ST.
WILKES-BARRE, PA.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOTES

New Equipment

(O) PIPE LINE FILTER

Four new small pipe line filter models, designed for installations requiring only 40 psi maximum pressures for com-

pressed air or gas, have been announced by the Dollinger Corporation. The new filters feature one-bolt accessibility for quick inspection and cleaning without removing filters from the line.

Circle letter (O) on reply card.

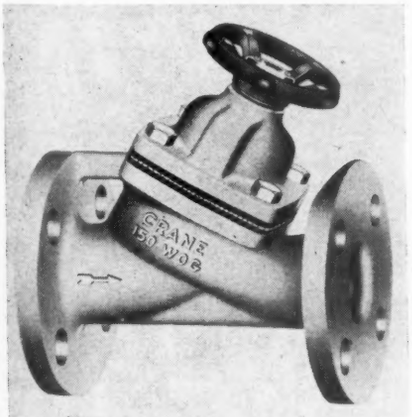
(P) GASKET MATERIAL

A new gasket material, Asbestoprene, has been developed from asbestos and the du Pont Company's synthetic rubber, neoprene. Asbestoprene is made by Victor Manufacturing and Gasket Company, Chicago, and is unusual in that it combines compressibility with heat resistance. In these two properties, Victor engineers say the new material fills a gap in their line of gasket materials between compressed asbestos sheet and cork or rubber.

Circle letter (P) on reply card.

(Q) DIAPHRAGM VALVES

Crane Company has announced the addition of several new body, diaphragm, and lining materials to its line of packless diaphragm valves. These

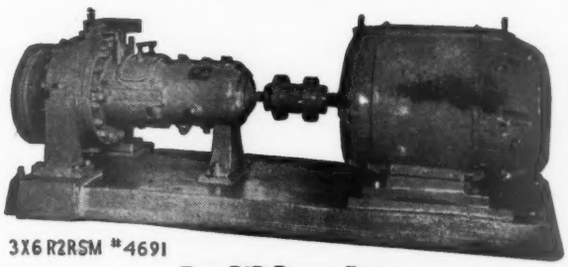


valves are now regularly available with cast iron, brass, aluminum, or 18-8 Mo bodies and disc holders; and with diaphragms and disc inserts of Neoprene, Buna-N, and soft natural hard rubber linings.

Circle letter (Q) on reply card.

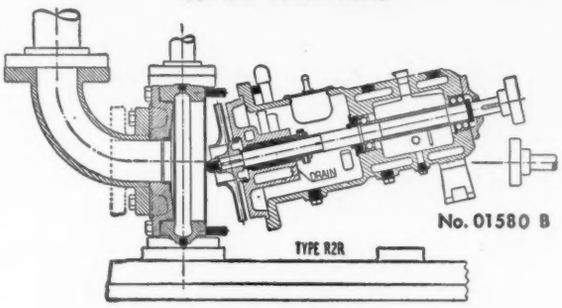
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



3X6 R2RSM #4691

Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

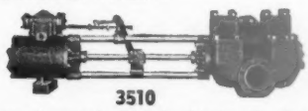
OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL AND RECIPROCATING PUMPS

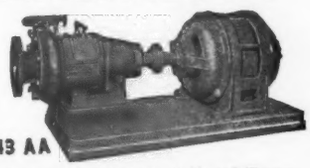
4640H

Close Coupled Centrifugal Pump



3510

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

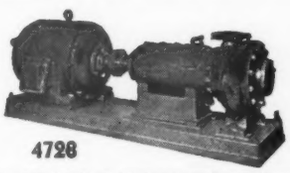


4043 AA

Pedestal Mounted Centrifugal Pump

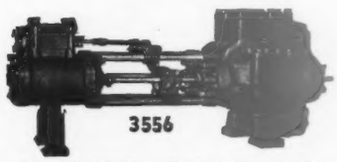
3833

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



4728

Double Pedestal Bearing Centrifugal Pump



3556

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

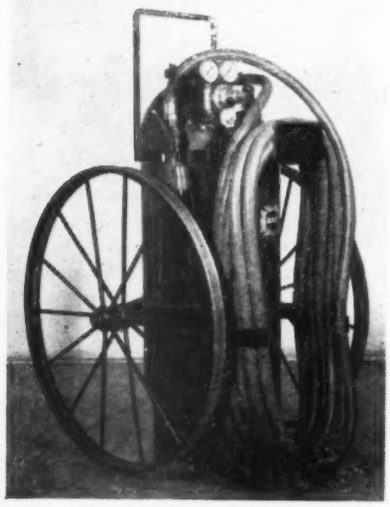
Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

New Equipment

(R) FIRE ENGINE

The manufacture of a new, powerful, one-man fire-fighting wheeled engine for extinguishing large-scale B and C fires has just been announced by the Ameri-



can-La France-Foamite Corporation. It is a dry chemical wheeled engine, with a capacity of 150 lb, and discharges free-flowing, Alfco Dry Chemical.

Circle letter (R) on reply card.

(S) BRAIDED SLINGS

A new 8-part braided sling, introduced by A. Leschen and Sons Rope Company, features a new type of reuseable thimble fitting that is reported to save sling users up to 20 per cent or more. These pin-lock thimbles are attached by pins.

Circle letter (S) on reply card.

(T) PLASTIC PIPE

Kraloy "D-500," a new rigid vinyl plastic pipe that can handle corrosive chemicals at 500 psi working pressure (77 F temperature), is now available in

½ to 4-in. sizes with all necessary molded fittings, according to the manufacturer, Kraloy Plastic Pipe Company, Inc. The new "D-500" plastic pipe is highly corrosion resistant.

Circle letter (T) on reply card.

(U) ETHYLENE OXIDE

The Lummus Company announces that it has been authorized to offer in the United States the use of the Shell Development Company's process for manufacturing ethylene oxide by the direct oxidation of ethylene and the production of ethylene glycol by hydration of the ethylene oxide. This process is the result of work begun by Shell several years ago and is now ready to be employed on a commercial scale.

Circle letter (U) on reply card.

(V) ANTIOXIDANT

Introduction of Impruvol 33, an antioxidant for motor and aviation gasoline that will provide engines with protection from fuel sludge and gumming at lower cost per gallon, was announced by Koppers Company, Inc. According to the company, Impruvol 33 may well be the answer to dirty engines resulting from catalytically cracked gasoline stocks.

Circle letter (V) on reply card.

(W) MECHANICAL PACKING

Abbott and Biddle has announced the development of a new type of mechanical packing design for use in the petroleumn industry. Utilizing Teflon, du Pont's new plastic, this new Teflon impregnated braided packing in field tests, has given as much as 10 to 30 times the length of service obtained with conventional mechanical packings.

Circle letter (W) on reply card.

(X) GEAR COUPLING

John Waldron Corporation has announced a junior coupling with a ¾-in. hub that has been tested safely to more than 1100 in. lb torque. The same major construction features of the modern gear type couplings so widely used for larger units is now available for nominal bores down to ⅜-in. diam. The coupling has two externally geared hubs enclosed in an internally geared sleeve that takes any size hub from ⅜-in. to ¾-in. bore.

Circle letter (X) on reply card.

(Y) VIBRATION PICKUP

A vibration measuring instrument of unusually small size, Type 4-118 Vibration Pickup, is announced by Consolidated Engineering Corporation. It measures only 1 by 1 in. and weighs only 1.3 oz—the 4-118 is designed for operation at the elevated temperatures encountered in testing of aircraft turbines, reaction motors, and superchargers.

Circle letter (Y) on reply card.

(Z) PIPE LIFTER

A new tool that can be used in the drilling business has recently been developed and placed on the market by Gem Oil Tool Company, Inc. It is a patented pipe lifter for the floorman to use while racking drill pipe. The tool consists of the essentials of the old "36" except instead of having a sharp, hard point against the smooth face of the tool joint, a hinged face of steel covers half the circumference of the tool joint so that pressure is evenly applied.

Circle letter (Z) on reply card.

(AA) MAKING UP TOOLS

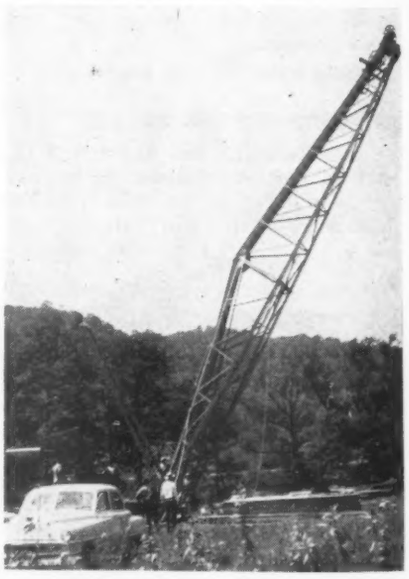
Dresser Equipment Company, IDECO Division, has announced that IDECO has been appointed exclusive jobbers for the Craigo Joint Rotor. Manufac-

tured by Craigo Supply Company, with a Joint Rotor one man can stab bits and subs in half the time ordinarily required for making up tools, it was reported. In tests on fishing and directional drilling jobs, the Joint Rotor has proved itself to be easy to operate.

Circle letter (AA) on reply card.

(AB) SPUDDER DERRICK

For ease in handling long strings of casing weighing up to 150 tons, a heavy-duty tripod type derrick is now available



as special equipment for the Bucyrus-Erie 48-L spudder, the manufacturer announces. The 70-ft 4-in. derrick is reported the first of its size and type designed especially for a spudder. It weighs 12 tons and is composed of four sections for easy erection, knockdown, and transportation in the field. Main front lower section is constructed with four laced channels.

Circle letter (AB) on reply card.

Trade Literature

Publication will be sent free.

(AC) MECHANICAL SEAL

Durametallic Corporation has published a 12-page bulletin on Dura seal, the engineered mechanical seal that is reported to rotate with the shaft. The catalog describes general types of styles of Dura seals designed to meet the sealing requirements of centrifugal and rotary pumps, autoclaves, agitators, blowers, and similar rotating equipment. The bulletin is fully illustrated.

Circle letter (AC) on reply card.

(AD) MOTOR VALVES

Minneapolis-Honeywell Regulator Company has announced a new specification sheet describing its Series 100 diaphragm motor valve. The valve provides optimum narrow-band proportional control at a minimum cost, the company states. Sheet 419-2 also gives pertinent data such as size, construction, body pressure range, connections, and complete mounting dimensions.

Circle letter (AD) on reply card.

(AE) CORRISON CONTROL

D. W. Haering and Company, Inc., has printed a bulletin in the shape of a barrel entitled "Contents—Solution to Your Problem of Scale and Corrosion Control." On both sides of the folder are listed the different kinds of corrosion controls with a list of places where material is most effective.

Circle letter (AE) on reply card.

(AF) MEASURING TENSION

Link Engineering Company has announced publication of a 4-page bulletin on Lod-Cap, a gage for measuring tension. Lod-Cap is said to insure the uniform tension of a product. Lod-Caps insure uniform weight and/or measure automatically, to any predetermined settings desired. Whether the tension is to be measured in ounces or tons there's a size Lod-Cap that will indicate it accurately.

Circle letter (AF) on reply card.

(AG CLEANING EXCHANGERS

Application of the Hydro-Blast high velocity sand-and-water method to the cleaning of heat exchanger bundles and other refinery equipment is described in a four-page bulletin offered by Hydro-Blast Corporation. The bulletin describes how this method has been installed in one of the country's principal petroleum refineries. In operation the gun carriage travels the full length of the enclosure and vertically in a range of 4½ ft. It swivels in a 90 deg cone, and is easy to move and control.

Circle letter (AG) on reply card.

(AH) V-BELT

High-capacity "Texrope" belts for tough jobs are described in a new bulletin released by Allis-Chalmers Manufacturing Company. According to the bulletin, high-capacity, "Texrope" V-belts carry 40 per cent greater horsepower rating, are oil resistant, and static conducting.

Circle letter (AH) on reply card.

(AI) PULSATION DAMPENER

Hydril Company announces forthcoming publication of a new bulletin on its pulsation dampener for slush pumps. Mounted on the pump in place of the standard air chamber, the pulsation dampener's function is to smooth out pressure peaks in the output line. The new bulletin, giving complete details and specifications, will be ready for distribution early in May.

Circle letter (AI) on reply card.

(AJ) INDUSTRIAL X-RAY

A buying guide for a complete and diversified line of accessories and supplies required for the industrial X-ray installation is available from the Westinghouse Electric Corporation. This 44-page illustrated catalog is divided into four basic categories: (1) films and chemicals; (2) radiographic accessories; (3) darkroom accessories; and (4) viewing and filing equipment.

Circle letter (AJ) on reply card.

(AK) VALVES

The Lunkenheimer Company is offering a new descriptive circular showing sectional views of its complete line of Renewo valves. This circular describes graphically the dimensions and features of the renewo line—permitting interchanging of matched seats and discs.

Circle letter (AK) on reply card.

(AL) ARC WELDING

Arc-welding accessories are described in a 12-page booklet available from the Westinghouse Electric Corporation. This line of products varies from electrode holders and ground clamps to protective clothing and headgear. All accessories are illustrated and in every case specification data are supplied.

Circle letter (AL) on reply card.

(AM) ROLLER CHAINS

A new bulletin on Baldwin-Rex roller chains and sprockets has just been published by Baldwin-Duckworth, division of Chain Belt Company. The 54-page book describes the inherent advantages of roller chain, and illustrates all the popular sizes of Baldwin-Rex Roller Chains. A section of the bulletin is a treatise on "how to select standard roller chain drives" . . . with formulas, tables and examples illustrating this procedure.

Circle letter (AM) on reply card.

(AN) STEEL BOLTING

Taylor Forge recently published Bulletin No. 524 on the subject of modern steel bolting for piping and pressure vessels. This was first presented as a paper before the seventh annual American Society of Mechanical Engineers, Petroleum Division Conference in Kansas City, Missouri, September 1952. This bulletin is now available to anyone interested in the proper selection of bolting materials.

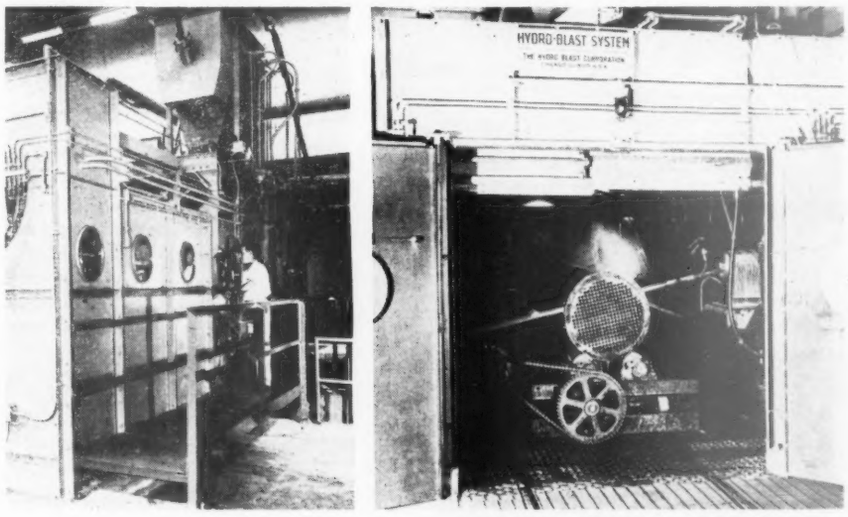
Circle letter (AN) on reply card.

(AO) TORQUE CONVERTERS

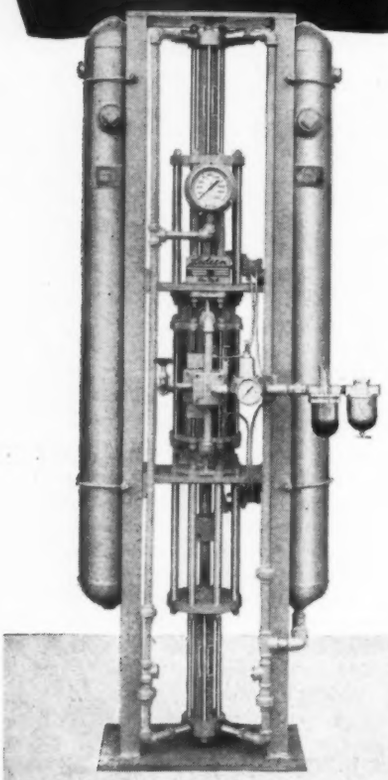
The inside story of the General Motors torque converter, now an integral part of a number of GM diesel engine models, has just been published by the Detroit Diesel Engine Division. The book is well illustrated with cutaway drawings, curves showing the horsepower characteristics of engines so equipped and photos of torque converter units at work in typical installations in the industrial, construction, logging, and petroleum fields.

Circle letter (AO) on reply card.

Exterior and interior of view of Hydro-Blast unit.



Ledeen
PUMPS



HIGH PRESSURE OIL
from
LOW PRESSURE AIR

Ledeen Heavy Duty Pumps and Power Units are built for operation of clamps, valve actuators, forming or drawing presses, safety installations, high pressure testing and other hydraulic circuits requiring adjustable pressure and volume and long pressure-holding cycles, without overheating the oil. Built as a complete package power unit, ready for easy installation, requiring connections only to incoming air line and outgoing hydraulic lines. Available in horizontal construction for minimum head room, and vertical construction for minimum floor space. Simple to install. Inexpensive to operate.

Write for Bulletin 4000

VALVES • CYLINDERS
AIR-HYDRAULIC PUMPS & BOOSTERS
VALVE ACTUATORS • AIR HOISTS

Ledeen Mfg. Co.
1608 San Pedro
Los Angeles 15, Calif.

Trade Literature

(AP) TUBING STEEL

One of the alloy tubing steels widely used in elevated temperature service is discussed in a new technical data card issued by the Tubular products division of The Babcock and Wilcox Company. Known at TDC-146, the bulletin discusses B&W Croloy 5 (4-6 per cent Chromium, ½ per cent Molybdenum). This steel has proved its value in refinery and other process industry applications as furnace tubes, piping, and superheater tubing.

Circle letter (AP) on reply card.

(AQ) BRONZE VALVES

Design and construction features of The Lunkenheimer Company's line of 125-lb pressure globe, angle, and check bronze valves are described and illustrated in a circular recently prepared by the company. Unusually large sectional views of these valves, showing their many outstanding features in complete detail are included in this informative circular.

Circle letter (AQ) on reply card.

(AR) CONDENSATION CONTROL

The Insul-Mastic Corporation of America, makers of a spray applied cork and Gilsonite mastic insulation, has produced a four-page folder containing charts that claim to show the exact degree of protection from condensation afforded by this insulation. Insulation is known as Insul-Mastic Type "D." The company states that Type "D" is a heavy spray applied coating produced to be used where a moderate amount of insulation is needed in conjunction with a corrosion preventive.

Circle letter (AR) on reply card.

(AS) HEAT EXCHANGERS

National Carbon Company, a division of Union Carbide and Carbon Corporation, announces the publication of a new catalog section covering its "Karbate" brand impervious graphite standard heat exchangers. The catalog fully describes the Series 310A and Series 90A standard heat exchangers, which replace, respectively, the Series 240A and Series 70A. The new exchangers employ completely removable "Karbate" impervious graphite tube bundles with stainless steel baffles, separate and removable "Karbate" impervious graphite fixed and floating end covers, etc.

Circle letter (AS) on reply card.

(AT) DRILL PIPE

Spang-Chalfant, division of the National Supply Company, has published a new 22-page, 2-color bulletin on the Spangweld drill pipe and double seal shrink thread. The drillpipe has tool joints flash-welded to the pipe instead of attachment by threaded connections. This reduces the number of threaded elements to one-third that of a conventional string of drill pipe and tool joints. The Spang shrink thread drill pipe and tool joints now have a second sealing surface at external end of threads.

Circle letter (AT) on reply card.

(AU) ACETYLENE STUDY

A technical and economic study on the new Wulff process for production of acetylene from light hydrocarbons has just been published by The Lummus Company. The 24-page report contains a process description and simplified flow diagram, followed by valuable data on plant and manufacturing costs. Sufficient information is available to adjust raw material, utilities, and operating labor costs and accounting procedures to specific cases.

Circle letter (AU) on reply card.

(AV) PULLEY PULLER

A new portable hydraulic pulley puller, rated at 50 tons pressure, has just been introduced by the Industrial Engineering Equipment Company. This new piece of equipment supplements two other pullers produced by the company, one of 5 tons and the other of 20 tons capacity.

Circle letter (AV) on reply card.

(AW) BUSHINGS

Aeroquip Corporation broach fit bushings provide for foolproof installations and precision results where thin-walled, hardened steel bushings are required. They fit the needs where bushings should be used but are not because conventional types are too costly . . . or where high precision bushings are used even though a less expensive type would serve equally well.

Circle letter (AW) on reply card.

(AX) ORGANIC GLUCOSATES

D. W. Haering and Company, Inc., has just issued a new booklet entitled "Solution to Your Problems of Scale and Corrosion Control." This booklet catalogs the various Haering glucosates and their specific use in open and closed cooling water systems, boiler waters, brines, air conditioning equipment, etc.

Circle letter (AX) on reply card.

(AY) OIL RECLAIMER

The Hilliard Corporation now has available upon request Bulletin No. R-247, describing Hilco Hyflow oil reclaimers that are an extension of their line of Hilco oil reclaimers but in higher capacities. Primary function of the Hilco Hyflow oil reclaimer is to maintain lubricating or industrial oils in clean condition by continuous removal of contaminants impairing efficiency.

Circle letter (AY) on reply card.

(AZ) DIALIFT TANK

The Dialift tank, a new means of conservation of volatile products, is fully described in Hammond Iron Works Bulletin 530L. Hammond Dialift tanks, for new storage installations or as a conversion of existing cone roof tanks, feature a membrane that functions as the "lung" of a single or battery of storage tanks. This membrane, attached gas-tight to the inside periphery of the Dialift unit, lifts with the pressure of gas or vapor accumulation and lowers as the gas or vapors diminish.

Circle letter (AZ) on reply card.

(BA) STAINLESS STEEL

The extra low carbon grades of stainless steel are fully explained in a booklet just published by Armco Steel Corporation. Grades are 18-8 ELC (Type 304 L) and 18-12 Mo ELC (Type 316 L). Some of the subjects covered are: Why carbon causes corrosion; how these special steels conserve scarce alloys; no need for a carbide dissolving anneal, etc.

Circle letter (BA) on reply card.

(BB) BULLDOZER

Baker Manufacturing Company's big 15X, heavy-duty bulldozer, is described in a bulletin just released by the company. Like the 9X counterpart, the Baker 15X integrates the Baker "roll-action" blade and the frame of the 109 drawbar hp Allis-Chalmers HD-15 tractor. It, too, features a 96-in. overall width (legal highway portability—no permits day or night) and a big capacity 51-in. high moldboard, which raises 39½ in. above ground and bites to 15½ in. below ground.

Circle letter (BB) on reply card.

(BC) MOTOR STARTER

The Arrow-Hart and Hegeman Electric Company announces the availability of a folder for engineers describing its new Type "RA-V" magnetic motor starters with vertical overloads below contactor. The new starters are manufactured for use especially in the new Crouse-Hinds M52 Type EPC explosion-proof condulets.

Circle letter (BC) on reply card.

(BD) RUST PREVENTIVES

The Rust-Oleum Corporation, has just released its new pocket-sized booklet featuring Rust-Oleum rust preventive coatings for the basic oil producing field. Included are 13 actual color chips for accurate color sampling, plus complete recommendations for application.

Circle letter (BD) on reply card.

(BE) FRENCH REFINERY

"Lummus at Dunkirk" is the title of a 16-page brochure just published by The Lummus Company. Booklet covers the company's role in the designing and building, at Dunkirk, France, of the modern integrated refinery of Société Générale des Huiles de Pétrole, an Anglo-Iranian Oil Company, Ltd., affiliate. Highlighted is how the new plant was conceived and built in amazingly short time to replace a refinery leveled during World War II.

Circle letter (BE) on reply card.

(BF) HEATING CATALOG

A 1953 edition of General Electric's catalog on Calrod electric heaters and heating devices has been announced as available from the company. Designated as GEC-1005D, the 60-page, two-color information and buying guide describes the equipments in terms of application, special features, installation, and pricing. The catalog also contains methods of determining power requirements.

Circle letter (BF) on reply card.

(BG) PIPE LINE CLAMP

A new bulletin on the Smith + Clamp developed by Pipe Line Development Company is now available. The new

clamp is used for repairing rust-hole or pit-hole leaks in pipe lines. The clamp can effectively control pit hole leaks at pressures of 2000 psi and higher.

Circle letter (BG) on reply card.

(BH) RECORDER CONTROLLER

A 16-page illustrated bulletin just issued by The Foxboro Company, describes the restyled Foxboro circular case controller. Showing typical applications in the food, textile, metal, and ceramic industries, the bulletin discusses each unit of a pneumatic control system, from the measuring element to the control valve.

Circle letter (BH) on reply card.

(BI) DISTRIBUTION PRACTICES

A new bulletin, a guide for plant engineers on electric power distribution practices in large and small plants, has been announced by the General Electric Company. The 28-page, illustrated, two-color bulletin, designated as GEA-5900, is entitled "Industrial Power Distribution Idea Book." It covers utility distribution practices; methods of buying electric power; what to do when a choice of primary voltages is available, etc.

Circle letter (BI) on reply card.

(BJ) DIESEL ENGINES

A unique and informative new booklet on diesels, written in simple, non-technical language, has just been published by the P&H Diesel Division, Harnischfeger Corporation. Entitled, "What You Should Know About Diesel Engines," it effectively calls upon the grade school "primer" technique for telling and illustrating diesel story.

Circle letter (BJ) on reply card.

(BK) GAS LOGGER

Petroleum Instrument Company has issued a 4-page folder titled "The Iron Man Geologist-Well Gas Logger." Pictures and descriptive material give a clear conception of how the well gas logger works—by analysis of the returning mud. The logger detects and records the minute gas shows returning from the drilled formations and the relative gas volume in same.

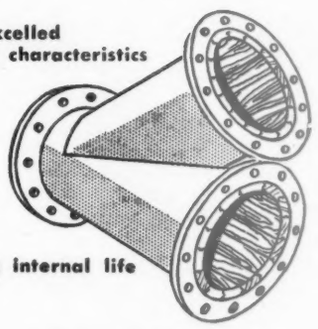
Circle letter (BK) on reply card.

5 reasons WHY

mpc WOOD-LINED STEEL PIPE IS IMPORTANT TO THE PETROLEUM INDUSTRY

1 Non-corroding

2 Unexcelled flow characteristics



3 Long internal life

4 Unexcelled cushioning capacity against pulsations, vibrations and other mechanical influences

5 Low cost

Combines the strength of steel with the durability of wood. Recommended for salt water lines, desalting service, dilute caustic soda and polysulfide transport, acid wastes, cooling tower service and oil gathering lines. Operating service up to 250 p.s.i. and 180°F. Higher pressure ratings for special service requirements. All pipe flanged and available in 10' and 20' standard lengths or custom fabricated to specifications. Diameters 4" thru 48". Easy to cut and re-flange. All flanges have standard ASME bolt circle.

Wood-lined fittings in standard and special designs for all diameters. For catalog and additional information, write Dept. PE.

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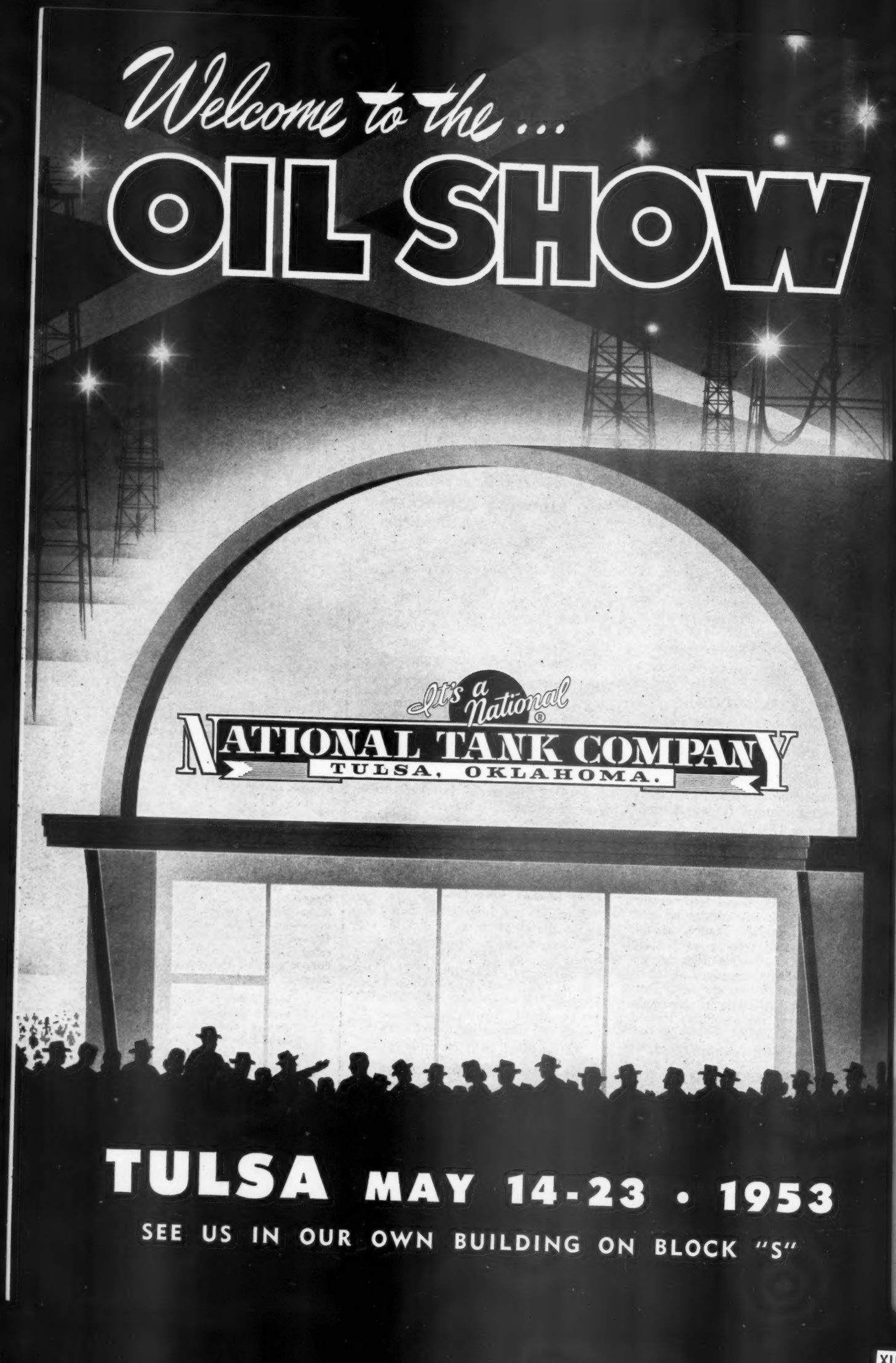
Bay City • Michigan

Manufacturers of Wood-Stave, Saran Rubber-Lined, Stainless Steel and Monel Piping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